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FORTY-SECOND ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

CONDUCTED JOINTLY BY THE

North Carolina Department of Agriculture

AND THE

North Carolina State College of Agriculture and Engineering

FOR THE

YEAR ENDED JUNE 30, 1919

INCLUDING BULLETINS Nos. 239 AND 241, AND TECHNICAL BULLETINS Nos. 15 AND 16

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LETTER OF SUBMITTAL

RALEIGH, N. C., June 30, 1919.

To His Excellency, T. W. BICKETT,
Governor of North Carolina.

SIR:—I have the honor to submit herewith report of the operations of the Agricultural Experiment Station, conducted jointly by the North Carolina Department of Agriculture and the North Carolina State College of Agriculture and Engineering, for the year ended June 30, 1919. This work is under the immediate direction of the "Joint Committee for Agricultural Work," provided for in chapter 68 of the Public Laws of 1913, and amended by chapter 223 of the Public Laws of 1917, and the report is made in accordance with the requirements of the act of Congress approved March 2, 1887, and known as the Hatch Act.

Very respectfully,
B. W. KILGORE,
Director.

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BULLETINS:

No. 239—The Tobacco Flea Beetle. By Z. P. Metcalf and G. W. Underhill.

No. 241—Soybeans and Cowpeas for North Carolina. By V. R. Herman.

TECHNICAL BULLETINS:

No. 15—A Monograph on Trembles or Milk Sickness and White Snakeroot. By F. A. Wolf, R. S. Curtis, and B. F. Kaupp.

No. 16—Clover Stem Rot. By F. A. Wolf.

BOARD OF AGRICULTURE

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*W. C. Riddick (President College), West Raleigh

STAFF OF THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION AND EXTENSION SERVICE

ADMINISTRATION

B. W. Kilgore	Director of Experiment Station and Extension Service
C. B. Williams	Vice Director, Experiment Station
R. W. Collett	Assistant Director, Branch Stations
S. G. Rubinow	Assistant to Director, Extension Service
F. H. Jeter	Agricultural Editor
A. F. Bowen	Bursar
Miss S. D. Jones	Bursar
Miss Mary S. Birdsong	Secretary to Director
H. C. Evans	Auditor and Executive Assistant

AGRONOMY

C. B. Williams	Chief in Agronomy
J. K. Plummer	Soil Chemist
W. F. Pate	Agronomist, Soils
E. C. Blair	Assistant Agronomist, Soils
S. K. Jackson	Assistant Agronomist, Soils
R. Y. Winters	Plant Breeding
V. R. Herman	Assistant in Plant Breeding
G. M. Garren	Assistant in Plant Breeding
S. J. Kirby	Assistant in Plant Breeding
†M. W. Hensel	Specialist in Sugar Plant Production
†W. E. Hearn	Soil Survey
†S. O. Perkins	Assistant in Soil Survey
L. L. Brinkley	Assistant in Soil Survey
†E. S. Vanetta	Assistant in Soil Survey
S. F. Davidson	Assistant in Soil Survey
†R. C. Jurney	Assistant in Soil Survey
W. A. Davis	Assistant in Soil Survey
E. H. Matthewson	Tobacco Expert
A. R. Russell	Assistant in Field Experiments

CHEMISTRY

W. A. Withers	Chemist	E. S. Dewar	Assistant Chemist
F. W. Sherwood	Assistant Chemist	R. A. Fetzer	Assistant Chemist
J. M. Pickel	Feed Chemist	G. L. Arthur	Assistant Chemist
W. G. Haywood	Fertilizer Chemist		

ENTOMOLOGY

Franklin Sherman, Jr.	Chief in Entomology
Z. P. Metcalf	Entomologist
R. W. Leiby	Assistant Entomologist
J. E. Eckert	Assistant Entomologist
†C. L. Sams	Beekeeping
†M. R. Smith	Extension Entomologist

HORTICULTURE

C. D. Matthews	Acting Chief, Division of Horticulture
J. P. Pillsbury	Horticulturist
L. R. Detjen	Assistant Horticulturist
L. H. Nelson	Assistant Horticulturist
J. M. Dyer	Assistant Horticulturist
P. T. Schooley	Extension Horticulturist

ANIMAL INDUSTRY

DAN T. GRAY	Chief in Animal Industry
R. S. CURTIS	Associate in Animal Industry
STANLEY COMBS	Dairy Experimenter
B. F. KAUPP	Poultry Investigator and Pathologist
†J. A. AREY	Dairy Farming
†W. W. SHAY	Swine Extension
†A. G. OLIVER	Poultry Extension
JOHN E. IVEY	Assistant, Poultry Investigations
E. C. WARDEN	Assistant, Poultry Investigations
†F. R. FARNHAM	Assistant in Dairy Farming
†A. C. KIMREY	Assistant in Dairy Farming
†D. R. NOLAND	Assistant in Dairy Farming
E. C. BRINTNALL	Assistant in Dairy Farming
†F. T. PEDEN	Assistant in Beef Cattle
†J. W. SLOSS	Assistant in Beef Cattle
EARL HOSTETLER	Assistant in Beef Cattle and Swine
†GEORGE EVANS	Assistant in Sheep

PLANT PATHOLOGY

F. A. WOLF	Plant Pathologist
R. A. JEHLE	Extension Pathologist
S. G. LEHMAN	Assistant in Bacteriology

DRAINAGE

†H. M. LYNDE	Senior Drainage Engineer
F. O. BARTEL	Junior Drainage Engineer

VETERINARY

W. C. REEDER	Veterinarian

MARKETS AND RURAL ORGANIZATION

†W. R. CAMP	Chief, Division of Markets
†O. J. MCCONNELL	Assistant in Cotton Grading and Marketing
†CHAS. S. JONES	Specialist in Livestock Marketing
GORRELL SHUMAKER	Assistant in Marketing Fruits and Vegetables
BOLLING HALL	Assistant in Marketing Fruits and Vegetables

FARM MANAGEMENT

†J. M. JOHNSON	Farm Management

BRANCH STATIONS

R. W. COLLETT	Assistant Director, in Charge Branch Stations
F. T. MEACHAM	Assistant Director, Iredell Branch Station
C. E. CLARK	Assistant Director, Edgecombe Branch Station
E. G. MOSS	Assistant Director, Granville Branch Station
S. C. CLAPP	Assistant Director, Buncombe Branch Station
A. S. CLINE	Assistant Director, Washington Branch Station

FARM DEMONSTRATION WORK

C. R. HUDSON	State Agent
H. H. B. MASK	Assistant State Agent
E. S. MILLSAPS	District Agent, Western District
T. D. MCLEAN	District Agent, Central District
J. M. GRAY	District Agent, Mountain District
O. F. MCCRARY	District Agent, Northeastern District
N. B. STEVENS	District Agent, Southeastern District

HOME DEMONSTRATION WORK

MRS. JANE S. MCKIMMON	State Home Demonstration Agent
MISS LAURA M. WINGFIELD	Assistant State Home Demonstration Agent
MRS. J. H. HENLEY	District Agent, Western District
MRS. ESTELLE T. SMITH	District Agent, East Central District
MISS MAUDE E. WALLACE	District Agent, West Central District
MRS. CORNELIA C. MORRIS	District Agent, Central District

FARM FORESTRY

H. B. KRAUSZ	Farm Forestry Specialist
J. WULFF	Assistant Farm Forestry Specialist

FARM MACHINERY

E. R. RANEY	Farm Machinery Specialist

The members marked with * are members of the Joint Committee for Agricultural Work, and the Station is under their direction.

†In cooperation with the U. S. Department of Agriculture.

Forty-Second Annual Report of the North Carolina Agricultural Experiment Station

FOR THE

YEAR ENDING JUNE 30, 1919

B. W. Kilgore, *Director.*
F. H. Jeter, *Agricultural Editor.*

The Forty-Second Annual Report of the North Carolina Agricultural Experiment Station covers the time of the closing of the great war, and the period of adjustment and reconstruction immediately following. Because of this, it has been necessary to make some rearrangements in the activities in which the workers are engaged, as well as to cope with conditions which naturally follow such a period of stress and unusual activity.

One of the great things to which the workers have been called upon to adjust themselves has been increased living costs, and a certain amount of unrest due to this reconstruction era. A number of the workers have returned from active war service, and are now busily engaged in their peace-time occupations. Many of them have found it somewhat hard to effect a complete adjustment to pre-war conditions. However, the Station staff as a whole has conscientiously carried forward all the problems in which it is engaged in rendering service to the agricultural interest of the State.

Due to the discontinuance of the emergency appropriations from the Federal Department of Agriculture, it has been necessary to release some few workers, and, therefore, to curtail activities in some directions. This has not seriously hampered the activities as a whole, and all the main problems which were being investigated are being carried along in a satisfactory manner.

The past year has been an unusual one for agriculture in the State. In the first place, weather conditions have made it a poor crop year. In spite of this, the total value of the crops has been considerably increased, and during the year the statistics show that North Carolina has come to be the fourth ranking State in the Union in total value of crops produced, amounting in value to $683,168,000. This has been largely due to the good prices prevailing for tobacco and cotton.

The State has also suffered from several outbreaks or epidemics of insects, notably that of the green clover worm in eastern North Carolina, and the fall army worm in several different sections. The latter part of the year 1919 also saw the first invasion of the State by the cotton boll weevil, it being found in parts of Columbia, Brunswick, New Hanover, and Robeson counties.

Good progress has been made on practically all of the projects now being studied by the different divisions. In addition to its regular work, the Division of Markets has been called upon to take charge of and and administer the cotton warehouse law passed by the Legislature of 1919, and put under the supervision of the State Department of Agriculture. Under the coöperative arrangement between the State Department of Agriculture and the State College of Agriculture, by which the Experiment Station is conducted, this activity was turned over to the Division of Markets and handled first by Mr. O. J. McConnell, later by Mr. W. R. Camp, Chief of the Division.

The past year has also been a great fair year in North Carolina. State aid has been extended to over 275 community, county, and district fairs, and the Experiment Station and Extension workers have been called upon to assist local men and women in the judging and handling of their fair exhibits. Practically all of the fairs have had a most successful season, and many of them are doing much to stimulate competition in producing better crops and livestock. An effort has been made to keep these fairs as educational in their nature as possible. In this way, a great opportunity has been given to foster improved methods of agriculture throughout the State.

As heretofore, the Station has continued its policy of existing only for the good of the farmers of the State, and in rendering service to North Carolina. Possibly never before has it enjoyed such a demand for its services. This is seen in the calls made on the workers for personal assistance, and in the great number of letters coming in from farmers and others requesting information on the problems confronting them. During one two-weeks period, when a careful count was made of the requests for publications, it was found that 973 separate letters and cards had been received.

The Station issued only two bulletins during the year, one being No. 239, on "The Tobacco Flea Beetle," and the other No. 241, on "Soybeans and Cowpeas for North Carolina." Two technical bulletins, the first being No. 15, "A Monograph on Trembles or Milk Sickness, and White Snake Root," and No. 16, "Clover Stem Rot," were also issued and distributed.

CHANGES IN STAFF

The changes in staff have been mostly with those members of the Agricultural Extension Service who were employed under emergency funds. However, a number of changes have also been made among the investigational workers.

During the year, Mr. W. R. Camp resigned as Chief of the Division of Markets to accept a position with the University of California.

Mr. W. W. Garnett, Assistant Superintendent of Credit Unions, resigned to go into similar work in Georgia, and Mr. O. J. McConnell resigned as superintendent of warehouses to go into commercial cotton brokerage work within the State.

Mr. A. J. Reed resigned as head of the dairy farming office, of the Animal Industry Division, to go into industrial creamery work in Raleigh, being succeeded by Mr. J. A. Arey, formerly county agent in Iredell County. Messrs. A. C. Kimrey and E. C. Brintnall were added to the dairy farming office during the same time to fill vacancies existing for some time.

In the Horticultural Division, Mr. C. D. Matthews has continued Acting Chief of the Division of Horticulture, being assisted by Messrs. L. H. Nelson, J. M. Dyer, and P. T. Schooley, who were secured during the latter part of 1919 to carry on the investigational and extension work of this Division.

Dr. G. A. Roberts resigned as Veterinarian to take up work in Brazil with the Rockefeller Foundation. He was succeeded by Dr. W. C. Reeder, assistant in his office. For the present, Dr. Reeder has devoted practically all of his time to college work.

W. J. Brockington resigned as Superintendent of the Trucking Branch Station in Pender County to return to county agent work, with headquarters at Fayetteville, in Cumberland County. For the present, Mr. R. W. Collett has had direct management of this branch station, as well as the general supervision of the other stations of the State.

Dr. J. K. Plummer, Soil Chemist, returned from a leave of absence during which time he was engaged in chemical research work for the War Department, and was elected State Chemist, succeeding Mr. B. W. Kilgore, who gave up this work to devote his entire time to the administration of the experimental and extension activities.

INTERESTING RESULTS SECURED

As quickly as certain truths have been determined by research work, these have been given to the people of the State by means of special articles in the Extension Farm News, and through a special service to the newspapers. In a similar way announcement has been made of all available publications issued. In this way the results of experimental work have been widely disseminated. In the same way the Agricultural Extension Service workers have taken the findings of the investigators and carried them direct to the people in the field.

This was strikingly shown during the year with the investigations being conducted on the muscadine type of grape at the Trucking Branch Station. Through several years of research work, done in coöperation with the Bureau of Plant Industry, the Station has determined that certain of the muscadine types, principally the Thomas and scuppernong varieties, are well adapted to growth in eastern Carolina, the fruit lending itself admirably to the production of home-made products such as grape juice, jellies, preserves, and other excellent foodstuffs.

To put these findings before the people of the State, there was held a short course, or grape products school, on this farm during the latter part of the year. Home Demonstration Agents from over the entire

southeast were present. Dr. George Dearing of the Bureau of Plant Industry had charge of the course of instruction, and explained carefully to the extension workers all the findings accumulated during the several years of investigational work. The idea of the Station is to gradually build up a great industry in home-made grape products. A number of women and girls in the home demonstration clubs have already taken up this project with good results.

The Division of Entomology determined, through research work in the field, that the soybean worm can be controlled in a practical way by dusting with dry arsenate of lead, mixed with dust lime in the proportion of 1 to 8. They found it was not necessary to attempt to get this poison on the under side of the leaves, as the worms quickly ate their way through and devoured enough of the poisonous material to cause their destruction.

In experiments with priming tobacco, as compared with cutting the stalk, the Division of Agronomy has determined in six years work, that considerable money can be saved tobacco growers by priming off the leaves as they mature. Fully 75 per cent of the tobacco growers of Granville County, in which the experiments were conducted, and from 40 to 75 per cent of the growers in the adjoining counties, have changed their methods of harvesting the tobacco crop since these results were published. The best tobacco men of the section estimated that this one thing has *saved farmers, during the past three years, not less than three to four million dollars, at the present prevailing prices.*

It has also been determined, in the work at this farm, that muriate of potash will make equally as good tobacco as will sulphate potash, from the standpoint of the grower. The Station is not ready, however, to advocate this practice generally, as no doubt the muriate form injures the burning quality of the tobacco produced.

In experiments recently concluded in some of the cheese factories of western North Carolina, it has been determined that from 8 to 9 pounds of cream can be secured from each 2,000 pounds of whey by the use of a whey separator. As this is a profitable investment for the factory, the machine costing only $400, one of the cheese factories has already purchased such a machine and installed it for permanent use. It is expected that the other factories will rapidly follow this example.

The Division of Animal Industry has found also that fish meal is a cheaper animal feed than tankage, causing slightly higher gains at a less cost. As fish meal is much more easily secured in North Carolina than the packing-house product, this work opens an important field for more economical feeding of hogs in the State.

It has also been determined from research work done with over a dozen dairy herds, that it cost just about 60 cents per gallon to produce and deliver milk. This is perhaps the most accurate information that has yet been secured on the cost of producing milk on the actual farm conditions in North Carolina.

One other notable piece of work to which attention should be called at this time is the result of the Division of Markets and the Animal Industry Division, in coöperation with the county agents of the Extension Service, to make coöperative shipments of livestock by the farmers. The investigations which have been done on this problem show that it is a very profitable thing for farmers to thus associate themselves and make such shipments. During the year many shipments of live hogs and sheep have been made to the larger markets. Several shipments of purebred cattle have been brought in in a similar way.

In the building of warehouses for cotton and other produce, reports during the year indicate that at least eleven counties of the State are making their plans to build, or have already begun construction under the State warehouse law, as administered by the Division of Markets.

AGRICULTURAL MEETINGS HELD AND ATTENDED

As in the past, all the members of the Station staff have devoted considerable time to attending meetings which were arranged, either by the experimental or extension service workers. This was especially true of the State Farmers' Convention at West Raleigh, the annual livestock meetings at Charlotte, and at other important meetings called by county agents and others all over the State. The Farmers' Convention this year was one of the most successful yet to be held from the standpoint of attendance and program. It was really one of the strongest meetings ever given for the advancement of agricultural interest in the State.

As usual, the Experiment Station has enjoyed the fullest coöperation from several of the State institutions, the daily, weekly, and agricultural press, business organizations, and other individuals and institutions working for the advancement of agriculture in North Carolina. Especially valuable has been the coöperation of the papers, the railroad workers, banks, chambers of commerce, and the counties of the State.

AGRONOMY

The main problems confronting the workers of the Division of Agronomy have to do with determining the plant food deficiencies of the soil, how to improve these so as to produce maximum crops, and building up to higher yielding strains the main staple crops which are grown in the State.

As the work of the Agronomy Division is founded largely on the findings of the soil survey, this basic work is being planned and pushed as rapidly as possible. Surveys were made during the year of Vance and Moore counties, and Durham and Guilford counties are now being mapped. After the soils of a given section have been mapped, experimental work can then be planned to show just what is needed in this type of soil to produce maximum crops.

One of the great problems with which the Division is confronted is to conserve the fertility of the soil, especially by the growth and handling of leguminous crops. Studies upon the amount of fertilizer to use on cotton have shown that at this time farmers are possibly not using the amount of fertilizer needed to give the largest net returns per acre. For instance, at the Iredell farm it was shown that the profit secured from using 200 pounds of fertilizer in 1917 amounted to about $40; while that secured from using 600 pounds amounted to about $82 per acre.

On account of the lack of potash in some of the fertilizer mixtures, especially with cotton on the sandier soils of the State, the reduction in the amount of potash has not only reduced the yield of cotton, but, in some cases, has lowered the resistance power of the plants to disease, and, in this way, greatly affected the yield. It has been found that nitrate of soda and sulphate of ammonia are the most efficient carriers of nitrogen in the promotion of crop yields.

A supply of lime is the first thing, after drainage, to assure a good crop yield on the muckland soils of the State. Generally, two tons of carbonate of lime per acre will give better paying results than one ton, or three tons.

From the experiments made with tobacco at the different farms, it seems that this time from 2 to 4 per cent of potash in the fertilizer mixture will be sufficient for the soils at the experimental farms near Reidsville. Muriate of potash in the mixture also gives good results from the standpoint of the grower, as has been previously stated.

Results with tobacco also show that by closer planting and better fertilization, the yield can be practically doubled, with the quality maintained to a high average.

The Agronomy Division has conducted crop improvement work with cotton in twenty-three communities of fourteen counties during the past year. In each case, except one, these communities have been led to adopt a better variety than those widely grown before the tests were made. Nine growers are now improving their seed cotton, as a result of this community testing, and it is estimated that they will have practically 5,000 bushels of improved seed for sale this fall. The Division is continuing its work of breeding high yielding strains of all the different leading crops of the State. The variety tests have proven that certain strains give larger yields in the different sections of the State. Experimental data are available now to show just which of these strains or varieties are more satisfactory. Some of the present high yielding varieties are also being bred up to a still higher standard, in order that the crop yields of the State may be constantly improved.

CHEMISTRY

The strictly research work of the Division of Chemistry has been continued along the same lines as in previous years, with the investi-

gators trying to determine at this time the best methods for use by mill operatives to produce a nontoxic cottonseed meal that will not injure the animals to which it is fed. Some investigations made during the year have determined why heating reduces the toxicity of cottonseed meal. The Division has shown that this toxicity is due to the presence of gossypol. This substance may be present in an unchanged form, or it may be changed to a nearly related substance which the Division has designated as D-gossypol, or it may be changed to some other substance. As a matter of fact, the gossypol itself seems to be more toxic than any of the substances derived from it.

ANIMAL INDUSTRY

As reported during previous years, the work of the Animal Industry Division is divided into various offices having charge of the classes of animals with which investigational work is being done. The work with swine is now being handled mainly on the Central Station Farm at Raleigh, and at two of the branch stations.

Some interesting experiments have recently been completed that show the importance of using a mineral mixture in the ration for hogs. It was found that where no mineral mixture was used it cost $24.96 to make 100 pounds of increase in live weight. Where a home-made mineral mixture was used it cost only $16.38 to make this 100 pounds increase. The one made and recommended, as a result of this experiment, consists of a mixture of 10 pounds of crushed charcoal, 5 pounds of air-slaked lime, 4 pounds of salt, 2 pounds of sulphur, and 2 pounds of copperas.

The work with swine has shown also that fish meal can be substituted for tankage, with the hogs making equally as good gains at a smaller cost. Some excellent data have also been secured on the curing of meat on the home farm. It has been found, during the past five years, that the shrinkage of cured meats, when liquid smoke was used, amounts to about 12.7 per cent, while the shrinkage when hickory smoke was used is 12.9 per cent. This proves, therefore, that the claims of the manufacturers of liquid smoke that their product permits the curing of meat with much less shrinkage is not justified. This work has also proven that meat cured from hogs fed on soybean pastures showed a shrinkage of 20.6 per cent, that meat from hogs fattened on peanut pastures gave a shrinkage during the curing process of 16.9 per cent, while the meat cured from hogs that had never been on a peanut or soybean pasture gave a shrinkage of 19.4 per cent. Some of the packers have discriminated against softbodied pork, giving as their reason that it showed a greater shrinkage on curing. This experiment, therefore shows that their claims are not justified.

Some excellent investigational work has been done during the year with poultry. Especially important has been that on the cost of raising chicks, which shows that at the present prevailing prices, the cost of the

feed for a chick is about 20 cents a pound, and this represents about 50 per cent of the cost of raising the chick during 1919.

In the breeding work with single combed white leghorns, the flock of birds layed an average of 89 eggs at the beginning of the experimental work. These have been bred and show an average of 135 eggs per year for the first two years since improvements have been made in the flock.

Dr. B. F. Kaupp is also making some interesting nutritional studies such as the mineral requirements for the growing birds, the value of velvet bean meal, and the use of skimmed milk in the ration for chicks.

Cottonseed meal is one of the standard feeds of the South, and is well suited to both sheep and beef cattle. Investigations are now being conducted to find out just how much of this meal may be used in the ration of breeding animals, and just how much roughage may be fed with it in a ration for sheep for best results.

Considerable work is also being continued on the wintering of stockers and feeder cattle in the mountains of western North Carolina, on the farm of Mr. T. L. Gwynn. These experiments have determined that it costs only half as much to keep the cattle through the winter on pasture as it does to winter them on such feeds as hay, corn silage, stover, straw, and grain.

Some of the outstanding efforts of the Dairy Office have been in a study of the cost of milk production, done in coöperation with the Federal Department of Agriculture. This work is now ready for publication, and a summary shows that it cost the farmers around Greensboro, where most of the studies were made, about 60 cents a gallon to produce and deliver their milk. This is perhaps the most accurate information that has yet been secured on producing milk under actual farm conditions.

The investigations made on recovering cream from whey at the Cove Creek Cheese Factory has resulted in this factory purchasing a whey separator, and it is probable that their action will be followed by other factories in this section.

As a whole, the Animal Industry Division has been unusually active during the year, as shown by the fact that they have held a total of 574 meetings, at which there were around 31,000 people. The members of this Division have also written about 22,000 letters in answer to requests for information. This is in addition to publishing articles in magazines, and in the newspapers of the State.

ENTOMOLOGY

Good progress has been made on all of the projects being studied by the Division of Entomology. The work with spraying potatoes has now completed its sixth year, with the past year showing a gain of 53 bushels of potatoes per acre by spraying with the home-made poisoned Bordeaux mixture. With early potatoes, increases varying from 50 to 191 per cent have been secured.

With the Larger Corn Stalk Borer, the experiments conducted over five years show that these borers may be greatly decreased by plowing under the stubble in winter, or by planting corn around May 25, as when planted at this date corn is only subject to the attack of one generation. When planted earlier, two generations affect the plants.

By dusting cabbage with arsenate of lead in air slaked lime it is found that an expenditure of around $6 will bring increased returns, varying from $50 to $175 in value, according to the prevailing market prices for the product.

The survey of the insect life of the State, which was begun 19 years ago, is being continued. During this year 147 species of insects have been added to the total list, which brings the number to 5,191 species at this time.

The work with the green clover worm on soybeans has been especially important during the year, due to the serious epidemic of this pest in the eastern part of the State. The studies made in the field, however, have shown that it may be controlled by poisoning with dry arsenate of lead, mixed with dust lime in the proportion of 1 to 8.

The Division has also traced the boll weevil into the State. This insect is now found in four of the extreme southeastern counties.

A great deal of work has also been done on a study of the leaf hoppers of the State, many field studies being conducted, as well as detailed work in the laboratory. The investigations on the control of the tobacco flea beetle have been completed and published in Bulletin No. 239. The experiments with the corn root worm are being continued at four different points in the State, and some valuable data have been secured with reference to this pest.

HORTICULTURE

In addition to the projects which have been studied during the past several years, a number of additional lines of work have been added during the year. The Division has now secured some additional workers for the purpose of carrying on these investigations. As heretofore, these investigations are concerned principally with pomology, a study of the native fruits, investigations with peaches, pecans, strawberries, vegetables, and with the muscadine type of grapes.

All the important varieties of fruit grown in the State are being studied to show the range of adaptability of the varieties in the different sections. The native fruits of North Carolina, their place of origin, their history and description are also being thoroughly studied, with paintings and photographs made of the most important varieties found.

In dehorning peach trees, it has been found that when buds are winter-killed by cold, this dehorning can be profitably done to renew the old trees. A good deal of interesting work is also under way to improve the present commercial varieties of peaches. A variety orchard containing about 60 different varieties of peaches was planted during 1917,

and these trees have now grown so satisfactorily that much active work can be done.

Twenty-two varieties of pecans have now been studied for nearly thirteen years, giving the Division of Horticulture enough accurate data to make recommendations regarding the best varieties for use in this State. During the past year the trees produced the largest crop of nuts in their history, some of them yielding over 50 pounds. Much information has been secured as to the best cultural practices of pecans, and methods of breeding and top working.

In the investigations with strawberries, twenty-three varieties have been tested in comparison with the Klondike and Missionary. While none of these varieties have shown themselves superior to these two for commercial purposes, a number of them have proven themselves valuable for home use.

About 19 varieties of sweet potatoes are being studied in eastern North Carolina to determine those most desirable from the standpoint of productivity, market value, and keeping quality. These tests are being made to determine the behavior of the different varieties in storage. It has been found that when good houses are used, the average loss from all varieties has been less than six per cent during the past year.

About twenty varieties of Irish potatoes are being studied to determine those best suited to conditions in western North Carolina.

At the Trucking Branch Station, in Pender County, the Division has a year-round observation garden that has been of much value as a demonstration in proving to the people of eastern North Carolina that a year-round garden is possible.

In connection with the investigations with the muscadine type of grape, six important lines of work are being attempted. Some of this work has already been reported on in the technical publications of the Station, notably Technical Bulletins Nos. 12, 17, and 18.

PLANT PATHOLOGY AND BACTERIOLOGY

Due to the resignation of Dr. W. H. Tisdale, who was in charge of the plant disease work during the absence of Dr. F. A. Wolf, in army service, the work in this Division has been hindered during the year. However, much data of value have been secured, especially in the laboratory. It is now planned to extend this work to field conditions for the purpose of securing adequate proof on methods of control of the several diseases which have been studied.

The Division has devoted considerable time to a heretofore little known vetch disease. It was very destructive in North Carolina during 1919, in a number of cases preventing the formation of seed.

The Division has issued one publication during the year, this being on Clover Stem Rot. Methods of control of the clover stem rot have been worked out, but in badly affected fields it has been found that cowpeas and soybeans must replace crimson clover as a legume in the rotation,

and winter grains must serve as cover crops if the disease is to be eliminated in any particular field.

One of the interesting lines of work in which the Division has been engaged during the year has been a study of the diseases of flue-cured tobacco, in coöperation with Mr. E. G. Moss of the Tobacco Experiment Station. Considerable data have been accumulated on this subject, and have been prepared in manuscript form for publication.

MARKETS AND RURAL ORGANIZATIONS

As heretofore, the work of this Division has to do with problems of marketing, warehousing, rural credits, and the proper grading of agricultural products. The Division has been especially active during the year in making surveys, in organizing the State cotton warehouse system, and in assisting in the formation of marketing exchanges. A number of surveys have been made which show the need of cotton warehousing and better credit facilities. While there are a great many small warehouses, these surveys show that there is still need for a much greater number.

The advantages of a warehouse can be seen in the fact that one warehouse holding 5,000 bales, which cost $15,000 to construct, made $125,000 for those who stored cotton in it that year. One bank loaned $250,000 on the cotton which it contained. The surveys show also that the large farmer usually obtains a higher price for his cotton, and if farmers were so organized to market their staple in large, even running lots through their own warehouse companies, they would not now be selling it at from one to four cents below the market, and losing in most places from $5 to $20 per bale.

With grain and soybeans there is also a great lack of warehouse space. The demand for corn has been less, due to the lack of a demand for wheat flour substitutes. Corn has been sold at a lower price than before, and soybeans sold from $1.50 to $2 per bushel, as compared to $3 and $4 last year. However, when the farmers had sold practically all of their beans, the price immediately rose to $3 per bushel, or better. The same is true of peanuts, in that immediately after the armistice there was a great decline from 9 cents a pound to about 4 cents. Reassurance to the growers on the part of the Division aided them in holding their nuts until the price had again reached a better figure.

Little selling assistance has been necessary in sweet potatoes, as the prices have generally been good. With the mountain products it was found that the growers had best have their Irish potatoes for sale in the late summer or early fall, as this is the only time that it pays them to put this crop on the market.

With hog marketing, the Division assisted in making eighteen coöperative shipments of fat hogs during the year. This idea is rapidly spreading over the entire State, and has been found to be a very profitable

method of marketing on the part of those farmers who have only a small number for sale.

Surveys with beef cattle indicate that the prices obtained by growers are usually considerably below the actual value of the cattle, due to the improper marketing conditions. Some sell their cattle too early, while others sell to dealers who contract with them anywhere from one to six months before delivery. Coöperative selling of fat cattle direct to the packers is being advocated to remedy this evil. The Division is planning to hold two big sales during the next year, and to develop the coöperative marketing scheme.

With sheep and wool, there were six coöperative shipments of sheep, while the wool from eight counties was collected and shipped to Philadelphia under the supervision of a livestock specialist. This idea is being pushed. It is planned to assemble all of the wool of the State in three or four places, and then offer it at auction.

The Division has devoted considerable time and attention to the organization of the State cotton warehouse system during the past year. Plans for handling this work have about been worked out, and at least eleven counties have taken up the proposition of building houses to store cotton when the price is too low. Surveys showed that cotton is damaged at least $2.50 per bale when allowed to lie in the open, and that this amount would supply enough money, if saved, to build all the warehouses needed in the State.

In the promotion and maintenance of marketing associations, the Division has aided in establishing one cold storage and marketing association for handling apples, potatoes, and cabbage in the mountains, two potato and cotton warehouses, and one strawberry association in eastern North Carolina.

At Aurora the Eastern Carolina Produce Exchange has been promoted for marketing Irish potatoes, with 150 cars being shipped during June, saving the growers from $15,000 to $25,000.

The Carolina Potato Exchange at Elizabeth City marketed for its members last year 169 cars of Irish and sweet potatoes at a good profit.

The Tabor Produce Exchange marketed 25 cars of strawberries, and the Mountain Growers' Exchange at Waynesville looked after the marketing of the perishable products grown in the mountains. Six carloads of late Irish potatoes were handled through this organization.

Twelve new credit unions were organized during the year, and three old ones given a new start. The resources of these unions have doubled during the past year.

Another matter to which the Division is rendering very valuable assistance is in the classing of cotton for farmers of the State. Six grading offices were maintained during the past year, and 26,081 bales of cotton were classed for farmers, and 4,036 were classed for cotton mills.

The Division also gave general assistance in the marketing of all products to individuals by listing these in a monthly farmers' market bulletin, and by personal assistance in finding markets where none existed locally.

DRAINAGE

The investigations of the Division of Drainage have been concerned chiefly with the question of farm drainage, making preliminary examinations of drainage districts, studying run-off on drainage canals, the efficiency of under-drains, and maintenance work on drainage canals.

During the past year preliminary examinations, surveys, designs, and reports for tile drainage systems have been made on 24 farms, in eleven counties, comprising a total area of 1,200 acres. Approximately 12,000 feet of tile have been installed on these farms.

Members of the Division have also given assistance on 36 farms in 19 counties to locate and construct terraces for the prevention of erosion. Approximately 44 miles of terracing have been laid out. Six examinations for drainage have been made, and reports issued to cover a total area of 119,000 acres. On Third Creek, in Iredell County, gaging stations for the determination of run-off have been studied on a watershed area of 44,000 acres.

The efficiency of under-drains has also been studied on two systems in Edgecombe County. This work has been in progress since 1916, and much valuable data is being secured.

For the purpose of studying the best methods and the cost of maintenance of drainage canals in North Carolina, about two miles of dredged canal, through Jacob Swamp in Robeson County, are being studied by the Division. A summarized report of this work for the years 1917 and 1918 has been prepared.

PUBLICATIONS

In addition to an Annual Report of 1,000 copies, four publications have been issued during the year. Bulletin No. 239, "The Tobacco Flea Beetle," and Bulletin No. 241, "Soybeans and Cowpeas for North Carolina," were printed, with a total issue of 26,000. Two technical bulletins, No. 15, "A Monograph on Trembles or Milk Sickness and White Snakeroot," and No. 16, "Clover Stem Rot," were also issued.

The experimental work, as heretofore, has been kept constantly before the people by means of articles in the Extension Farm News, and in the Special News Service supplied to the press of the State.

The bulletins of the Department of Agriculture have also been used to give the results of the experimental findings of the Station workers. These have been issued, one each month, with about 15,000 copies of each bulletin being printed.

Multigraph material has been edited and distributed to the special mailing lists maintained by the Station. There is now a total of around 60,000 names on the various mailing lists. These are kept up to date, and an effort has been made during the year to keep the lists from growing too large. However, all published material is well advertised in the press, and those who care to do so may secure copies by writing to the Station. In this way the publications are sent only to those who will be interested in receiving them.

Attention is called to the reports of the heads of the several divisions, and to the financial statements which follow:

FINANCIAL REPORT

The North Carolina Agricultural Experiment Station, in account with the United States Appropriation, 1918-1919:

Dr.

	Hatch Fund	*Adams Fund*
To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1919, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund)	$15,000.00	$15,000.00

Cr.

Salaries	$6,735.56	$12,659.07
Labor	2,888.79	896.15
Publications	895.97	
Postage and stationery	136.91	93.85
Freight and express	48.99	7.13
Heat, light, water, and power	168.45	84.25
Chemicals and laboratory supplies	54.77	127.87
Seeds, plants, and sundry supplies	689.01	204.22
Fertilizers	731.70	279.25
Feeding stuffs	1,097.36	9.00
Tools, machinery, and appliances	371.75	115.50
Scientific apparatus and specimens	115.00	107.04
Livestock	129.00	250.00
Traveling expenses	166.74	166.67
Contingent expenses	20.00	
Buildings and land	750.00	
Total	$15,000.00	$15,000.00

The North Carolina Agricultural Experiment Station, in account with Farm and Miscellaneous Receipts.

Dr.

Receipts from other sources than the United States for the year ending June 30, 1919	$7,370.83
Balance on hand	1,616.70
Total	$8,987.53

SUPPLEMENTAL STATEMENT

Cr.

Labor	$252.22
Postage and stationery	94.34
Freight and express	122.55
Heat, light, water, and power	11.39
Seeds, plants, and sundry supplies	17.96
Feeding stuffs	25.00
Library	534.53
Tools, machinery, and appliances	127.83
Furniture and fixtures	56.10
Livestock	810.00
Traveling expenses	25.73
Buildings and land	2,835.39
Balance	4,074.49
Total	$8,987.53

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the North Carolina Experiment Station for the fiscal year ending June 30, 1919; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasury of the United States are shown to have been $30,000, and the corresponding disbursements $30,000, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving nothing.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress, approved March 2, 1887, and March 16, 1906.

(Signed) C. E. Thompson,
D. R. Noland,
H. L. Stevens,
Auditors.

(Seal.)

Attest: A. F. Bowen, *Custodian.*

REPORT OF THE DIVISION OF AGRONOMY

To the Director:

During the year the main efforts of the workers of the Division of Agronomy have been (1) to determine the main plant food deficiencies of the soils of the State and how to most economically meet these in the profitable production of crops; (2) and in improvement work with the main crops of the State to secure more prolific strains of these through breeding.

Although the work has had many interruptions, the experiments have not only been kept in force and in good shape, but some progress has been made. Below is given a brief statement with reference to the status and progress of the main lines of work.

SOIL SURVEY

This work was interfered with by the war, more than any other line of work being carried on by the Division, because of the loss of all the men into military service. They have all now returned and work is progressing actively. During the year surveys of Vance and Moore counties have been completed, and work is now progressing in Durham and Guilford counties. At the present time there are three State and three Federal men in the field in the survey work. It is of the highest importance that the survey be pushed aggressively, so that the State may be completed at as early a date as possible.

As stated in previous reports, the soil survey is the basic work on which our field experiments are planned and are to proceed in the future.

CONSERVING FERTILITY OF THE SOIL

Of all times, this is the one that farmers of the State can least afford to neglect the producing powers of their soils. Where fertilizers are used intelligently, with most crops, they will pay as well or better now than they did three or four years ago, notwithstanding the material

advance in price. The reason for this is that farm products have advanced, in many cases, more than have the fertilizing materials.

Of all times, too, this is the one, as fertilizers are high, in which farmers should exercise the greatest care in the selection of the fertilizers to be used on their different crops. Growers should know the needs of their soils and of the crops that are to be grown, and buy most economically to meet these needs. The Division of Agronomy has a great amount of information with reference to the needs of different crops grown on different kinds of soils of the State, and is thus, at all times, prepared to supply this information to those seeking it.

Notwithstanding the high price of seed of most legumes, it is very essential, as far as it is practical, for farmers to utilize these to a greater extent than has been the case heretofore. Such crops, when handled properly, will supply nitrogen to the soil, the most expensive plant-food constituent needed by our soils. This constituent is one of the main limiting factors in the production of crops on most of our soils. In growing such crops as crimson clover, hairy vetch, red clover, bur clover, soybeans, cowpeas, and velvet beans, in the different localities where they are adapted, when these crops are put in well and inoculated properly, where need be, one is able to have a large amount of nitrogen taken from the illimitable supply of the air and stored in the soil when all or a part of these crops are plowed under. As far as practical for the farmer to do so, he should plow in some or most of these crops when grown on his farm. Especially is this so where they have been grown on soils that are low in organic matter. A moderate growth of each of these legumes on a field should, when turned under, add to the soil, of nitrogen taken from the air, something like 70 to 100 pounds per acre. Of course, the number of pounds added will depend upon the amount of growth, and to a less extent upon the kind of legume. If one will calculate what 75 pounds of nitrogen would cost now in commercial fertilizers, he will appreciate the value of a good growth on the soil of any of these leguminous crops.

In order to succeed on most of our soils, especially on those that have not received an application of lime during the past three or four years, it will ordinarily be necessary to make an application of ground limestone, or some other suitable form of lime, at the rate of a ton and a half to two tons of calcium carbonate per acre. Again, phosphoric acid will usually be required for best paying results. Generally, an application of 200 to 300 pounds per acre of 16 per cent acid phosphate will be sufficient on the better grade of soils. Where the soil is very poor, and no manure or leguminous crop has been plowed in the land, a small amount of cottonseed meal, or some other suitable carrier of nitrogen, should be used with the acid phosphate in suitable amounts to carry one to two per cent of nitrogen in the mixture.

Plants are the only things that can take materials from the soil and air and manufacture them into food products of different kinds for man

and beast. Therefore, it is of the highest importance that we treat our soils and handle our crops in the most favorable way, so that we may have them produce the largest possible amount of food. This will not only be a wise thing to do on the part of the State, but should at the same time be a profitable operation for the individual farmer.

EFFECT UPON PROFIT OF QUANTITY OF FERTILIZER USED ON COTTON

Attention is called to the fact that it has been found that the profitableness of the use of commercial fertilizers, not only depends upon the composition of the fertilizer used, but also upon the relative cost of the commercial fertilizer and the selling price of crop or crops. This fact is brought out very strikingly in the tables given below.

Where good farming is done, and the right kinds of fertilizers are used, generally, the quantity of fertilizer per acre is not in sufficient amounts to give the largest net returns. Other things being equal, the most profitable yields should be secured by materially increasing the yield per acre, above what they are on an average at present, and, if necessary to maintain a definite yield for the farm, reduce the acreage of the crop. In other words, where good farming is done, relatively large yields per acre are best. Not the largest yields, however, are always the most profitable ones. The above claims are based upon the results from long continued experiments conducted in different parts of the State.

Average Results at the Central Farm. Below is given the profit from the use of different quantities of fertilizer per acre in 1913 and in 1919:

Amount of Complete Fertilizer Per Acre— Pounds	*Value of Increase Per Acre Above Cost of Fertilizer*	
	In 1913	*In 1919*
200	$16.12	$37.97
400	19.57	46.11
600	25.50	50.06
800	22.01	51.85
1,200	22.04	51.95

In making the above calculations for profit in 1913 and 1919, the increased yields from the different fertilizer applications were used, above what was secured where no fertilizer was applied. The same average yields were used in making the calculations for 1913 as for 1919. The difference in the profitableness of the two years is due to the relatively higher selling price of the cotton, over the cost of fertilizers.

Average Results at Iredell Farm. Similar results for cotton, to those secured at the Central Farm, are given from data secured in many years study at the Iredell Farm. On this latter farm the quantity of complete fertilizer used per acre varied from 200 to 1,000 pounds applied in the drill at planting. Below is given the value of the increases in 1914 and in 1917, calculating at the average selling price of seed cotton and the cost price of commercial fertilizers prevailing during the two years.

The average results secured show the relative profitableness of different quantities of fertilizer used per acre in 1914 and in 1917 to be as follows:

Amount of Complete Fertilizer Per Acre—Pounds	*Value of Increase Per Acre Above Cost of Fertilizer*	
	In 1914	*In 1917*
200	$16.00	$40.13
400	27.59	69.59
600	32.30	82.11
800	33.84	86.16
1,000	36.86	95.38

Average Results at Edgecombe Farm. On this farm, which is located on the Norfolk fine sandy loam soil, the prevailing type in the eastern portion of the State, there have been, on an average, material increases in gains from the use of different quantities of a complete fertilizer up to 1,200 pounds per acre. The average results secured are as follows for 1914 and 1917:

Amount of Complete Fertilizer Per Acre—Pounds	*Value of Increase Per Acre Above Cost of Fertilizer*	
	In 1914	*In 1917*
300	$18.15	$45.34
600	24.40	62.13
900	27.90	72.31
1,200	34.55	90.06
1,500	33.50	89.32

It will be observed from the above data that on an average, both in 1914 and in 1917, the best paying results, above the cost of fertilizer, were from an application of 1,200 pounds per acre. When the quantity was increased above this the profit was less.

POTASH REQUIREMENTS OF EASTERN NORTH CAROLINA SOILS

If satisfactory crops are to be produced, it has been found absolutely necessary, in addition to supplying a sufficiency of available phosphoric acid and nitrogen to the soil, that ample potash, too, will be present in suitable form to supply the needs of the growing crop. Where too small an amount of this constituent in available form is present in the soil for good yields, the crop cannot be other than small.

Before the breaking out of the European War, the farmers in this State, as well as those throughout the country, were almost entirely dependent upon the deposits in Germany for their supply of potash contained in the fertilizer mixtures they were using. Hence, when this great catastrophe came, and all shipments from Germany were cut off, it left this country almost entirely, for the time being, without a potash supply suitable for agricultural purposes, except a small reserve which was in the hands of dealers, manufacturers and farmers, and that derived from waste products on farms. In consequence of this condition, the price of potash shot upward and has ever since remained high in price, notwithstanding the fact that a considerable domestic supply of this constituent has been developed during the past three or four years.

As a consequence of the scarcity and high price of potash, there has been, on the part of farmers of this State, a material reduction in the percentage of this constituent used in the fertilizer mixtures for different crops, and in many cases the reduction has been to such an extent as to materially affect the yields, as well as the quality of the crops. Particularly has this been the case with such crops as tobacco, which require a large amount of potash to produce the highest grades. In the growth of cotton on some of the sandier soils of the eastern part of the State, the leaving out, or the reduction of potash in the fertilizer mixtures to too small a percentage has, in many cases, not only directly affected the yields, but appears to have materially lowered these by reducing the resistance power of the plants to some of the more common diseases to which cotton is sometimes subject, when grown on some soils in this State. Crops are dependent upon the potash present in the soil, or that added in available forms in fertilizing materials. It is, therefore, of the highest importance that a sufficiency of this constituent be present in the soil in available form, so that plants can make satisfactory growth; in other words, so that potash will not be the limiting factor in the growth of crops.

Outside of the Albemarle section of the State, most of the soils thus far studied in the east contain from a moderate to a low content of potash. Even with the soils in the Albemarle section that are high in potash, it has frequently been found advisable to add this constituent to some crops in order to get the best paying results. Especially has this been found true of crops like tobacco and potatoes that require considerable amounts of potash when grown on soils low in organic matter. It should not be inferred from this, however, that a lavish use of materials carrying potash is to be recommended. As a matter of fact, it is of the highest importance that only amounts needed by the crops shall be added to supplement that which is available in the soil. The potash in eastern soils, generally, appears to be contained in rather a refractory form, so that it is brought into solution in the soil water only with the greatest difficulty. Generally speaking, however, this constituent frequently comes next to nitrogen in importance, and must be supplied to the soils for the best growth of the main crops grown in that section of the State.

There are sources of this constituent in the waste materials on every farm, that have not heretofore been carefully saved and applied to the soil, because of the fact that farmers felt that potash could, in many cases, be bought more cheaply than when derived from waste materials around the farm. Wood ashes, when properly looked after, will supply a good amount of this constituent. However, if they have been allowed to lie out in the rain the potash which they contain, being readily soluble, would be washed away. A good grade of wood ashes that has not been allowed to leach will ordinarily contain from 4 to 6 per cent of potash. If leached thoroughly, the percentage of potash would probably be reduced to from ½ to 2 per cent, the amount left in the ashes being de-

pendent upon the amount of leaching. It is, therefore, of the highest importance that ashes, where wood is burned on the farm, should be saved to be applied to the field crops that have the greatest need for this constituent. The ashes derived from hardwoods will ordinarily contain a higher percentage of potash than will those that come from the soft woods, like pine. Coal ashes have practically no fertilizing value and, therefore, should not be saved to apply to the soil with the hope of supplying potash. Woods mould, stable manure, and other farm manures of different kinds contain more or less potash, although their main constituent is generally nitrogen. These materials should be carefully saved to apply to the soil, as they supply potash, as well as nitrogen and phosphoric acid. One of the most important sources of potash on tobacco farms is tobacco stems and waste tobacco leaves. At the present price, tobacco stems and leaves per ton will contain from $25 to $35 worth of this constituent. In other words, it would require the expenditure of this amount in commercial fertilizer to purchase the same amount that is contained in these waste materials on many tobacco farms. All these materials should be scrupulously saved and applied to the fields, as they will supply the required amount of potash needed by the plants for the following year. In order to facilitate their rotting, they can either be chopped up or composted.

RELATIVE EFFICIENCY OF DIFFERENT CARRIERS OF NITROGENOUS MATERIALS

The relative value of nitrate of soda, sulphate of ammonia, calcium cyanamid, dried blood, and cottonseed meal, as carriers of nitrogen in commercial fertilizers, has been brought out as the results of long continued field experiments by the Division of Agronomy.

The experiments were conducted on the large soil type areas of North Carolina to determine the relative efficiency of the different carriers of nitrogen for plant food purposes, as measured by crop yields. From the results of work that has been conducted up to this year, it has been found that nitrate of soda and sulphate of ammonia are most efficient in promoting crop yields.

Particular attention is called to the fact that there are conditions under which these materials cannot be used very satisfactorily, except in a rather prescribed way. For instance, on very coarse sandy soils, that are underlain by a coarse sandy subsoil, and, therefore, of a very leachy nature, these very soluble materials are likely to be lost from such soils before crops are able to secure much of them, if applied at the time the crop is planted. Especially will this be so if the season is at all wet; under which circumstances they have to be used with considerable precaution. These precautions were, of course, observed when measuring the efficiency of these carriers as against the organic carriers—cottonseed meal, dried blood, and calcium cyanamid.

The average field results show that the efficiency of the different common nitrogenous fertilizer carriers is nitrate of soda, sulphate of ammonia, calcium cyanamid, dried blood, and cottonseed meal for cotton —and nitrate of soda, sulphate of ammonia, calcium cyanamid, cottonseed meal, and dried blood for corn in the order given when the yields were considered. The same amount of nitrogen for the same crops was equal from all sources each year. There was a normal application of phosphoric acid and potash used with the different nitrogenous carriers.

SOIL FERTILITY INVESTIGATIONS

The main work in soil fertility is being conducted by the Division of Agronomy at the Buncombe, Iredell, Central, Granville, Edgecombe, Washington, and Pender farms. Throughout the State many soil type experiments are being conducted on the farms of farmers for the purpose of supplementing the main lines of investigation. These latter are so located that the results from them will have as wide application as possible to the main soil type areas found in the State. It has been found in these experiments that not only the farmer carrying on the coöperative work is much interested in the results of the experiments, and has used them to benefit himself, but other farms in the respective communities are beginning to use the results in their farming operations. At present, the outlying fields are located on the types of soil and at the points given below:

For Mountain Section

On Toxaway Silty Loam, near Andrews.

For Piedmont Section

On Cecil Sandy Loam, near Winston.
On Cecil Sandy Loam, near Gastonia.
On Mecklenburg Clay Loam, near Concord.
On Granville Sandy Loam, near Franklinton.
On Granville Coarse Sandy Loam, near Louisburg.

For Coastal Plain Section

On Norfolk Fine Sandy Loam, near Rocky Mount.
On Portsmouth Fine Sandy Loam, near Pantego.
On Muck, near Moyock.

The Division is also carrying on similar soil fertility work, in cooperation with a number of farm life schools of the State, with the idea that the results will be of considerable value to the teachers of agriculture in these schools in vitalizing the subject of agriculture with their students. It is felt, too, that the results of these experiments should be of considerable value to the farmers in the communities surrounding these schools, and should be a means of drawing the attention of the patrons to the value of the work which is being done on the school farms,

and also to the reliability of the information which the teachers of the different schools are giving to the boys studying agriculture. These latter tests are being carried on at the following points:

In Piedmont Section

China Grove Farm Life School, in Cabarrus County.
Lowe's Grove Farm Life School, in Durham County.
Parrish Agricultural High School, in Durham County.
Jamestown High School, in Guilford County.

In Coastal Plain Section

Red Oak Farm Life School, in Nash County.
Philadelphus Farm Life School, in Robeson County.
Sand Hill Farm Life School, in Moore County.
Craven Farm Life School, in Craven County.
Aulander Farm Life School, in Bertie County.
Wakelon Farm Life School, in Wake County.

SPECIAL TESTS

These tests were started during the past spring at Whitakers and Williamston to study the effects of lime, gypsum, and sulphur upon the yield and growth of peanuts. It is too early yet to make any deductions from results secured.

At Aberdeen, Lowe's Grove, and at the Central Farm tests were started this spring, too, to determine the value of nitrate of soda and sulphate of ammonia as a top dressing for cotton. In these tests, applications of the nitrogenous materials were made to the crop on four different dates during the growing season.

At the Washington Farm. In fertilizer experiments at this farm it has been planned to study the effect of different combinations of fertilizers on the peat soils, with and without lime when used singly, in combination with two, and with all three of the plant food constituents. In the test, one plat has been supplied with basic slag, as a source of phosphoric acid, for a comparison with acid phosphate as a carrier of this constituent. Although there have been some crop failures in these experiments, sufficient data is available at present to cause us to believe that a supply of lime is the first thing required after drainage, to be assured of good crop yields. The use of two tons of carbonate of lime per acre has given better paying results than has the use of one ton. Three tons per acre have been found less effective than the use of two tons. Burnt lime, up to this time, has not been found superior to raw ground limestone as a carrier of lime in the carbonate form. The addition of phosphoric acid and potash, used alone and in combination, has shown no benefit, and sometimes has had a depressing effect upon the yields.

In the growth of corn, oats, and soybeans on Field A, corn thus far has been the only successful crop. It is possible that oats might have done better. Soybeans grown under the conditions existing here, it is felt, should, by all means, be inoculated. Nitrogen, in one case, has shown some benefit, but on an average, when used alone and with phosphoric acid and potash, has been found to have but little value for the soils of this farm in their present condition.

Increasing the amount of lime per acre to about two tons has resulted in increased crop yields. To be enabled to answer the question as to how much and what form or forms of lime to use on the kind of soil, as represented by this farm, special lime experiments were begun during the spring of 1917; three forms of lime—hydrated, ground limestone, and marl—being tested. The quantities of each that are being used in the experiment have been secured, and indications are that the use of more than one ton of lime per acre is needed for best crop returns. There is a strong indication, too, from the data thus far secured, that marl is not as efficient a carrier of calcium carbonate as the other forms of lime. The need of lime was strikingly shown during the past winter and spring with a cover crop of rye on the regular fertilizer plats. Up to the first of February of this year, over the entire field, both where lime was applied and where it was not, there was a good stand of rye. Soon after this date, the crop on the unlimed end of the plats began to die out, until by the first of April the land was practically bare. The growth of rye on all the plats where lime was used produced a very good growth.

At the Pender Farm. Experiments are being conducted at this farm to determine the combination of plant food constituents best suited for the growth of corn, oats and vetch, and cotton in a three-year rotation. Because of severe attacks of corn bill bug, and other unfavorable conditions, there have been some failures in the crops. So far, nitrogen has been proven the best constituent for better crops. Phosphoric acid with nitrogen has given more increase than has potash with nitrogen.

The use of lime has shown up well, especially with soybeans. In the experiments, basic slag up to this time has not been found quite as satisfactory a carrier of phosphoric acid as has acid phosphate.

Last year an experiment was started to test the relative efficiency of the different common carriers of phosphoric acid, with and without applications of lime.

At the Edgecombe Farm. The main fertilizer tests at this farm are conducted on Fields A, B, and C. On these fields a three-year rotation of corn, cotton, and peanuts, with a cover crop each year, is being used. From the average of these tests, nitrogen and potash have shown to be constituents of plant-food of first importance for best crop yields. When larger amounts of nitrogen and potash are used in the experiments, phosphoric acid begins to show up to much greater advantage. The results, as a whole, show in a very striking way that farmers, generally, in the eastern section of the State, are not using enough fertilizer for cotton

to secure the best paying returns per acre, as long as cotton remains high in price. Neither is the fertilizer best proportioned ordinarily for the most economical gains. Ordinarily, more nitrogen and potash should be used in the mixtures, and a little less phosphoric acid. The use of lime alone has shown splendid returns for each dollar invested on both cotton and corn.

In the rotation tests, the results show that corn and cotton, on the same land every year, afford better yields than a rotation of corn and cotton when fertilizer is used in all cases. When legumes are used in the rotation, and a crop of oats is included, much better yields of all crops are produced. The study of the value of farm manure has led to the belief that the organic matter which it contains is an important factor on the character of soil found at this farm.

In the study of different sources of nitrogen, nitrate of soda still leads as a carrier of nitrogen in crop production, with sulphate of ammonia coming second.

A test has been started on this farm recently to determine the relative winter-killing of crimson clover grown from foreign and native seed.

At the Iredell Farm. On the cecil sandy loam soil of this farm, the evidence is still conclusive that the use of available forms of phosphoric acid and nitrogen are the main controlling factors in the hands of the farmer for the production of better crop yields. With both cotton and corn, on an average, the use of lime has given splendid results. It is believed that, as the organic matter supply of these soils is increased, it will have a marked effect upon the beneficial influence of lime applications and commercial fertilizers, as measured by crop yields.

In the rotation tests, the average results show that corn every year and wheat every year with fertilizers are no more exhausting upon the fertility of the soil than a two-year rotation of corn and wheat with fertilizers. By the use of legumes, like red clover in the rotation, a marked increase in the yields of both crops is secured.

In the study of the different carriers of nitrogen, nitrate of soda, and sulphate of ammonia, the mineral sources have been shown to be more efficient in the promotion of crop growth and yields than the organic sources like dried blood and cottonseed meal. There appears to be no residual nitrogen left in the soil, as indicated by crop growth on those plats which have received organic carriers of nitrogen. Potash used alone has been frequently observed to depress the yields below what was secured where no fertilizer at all was applied on this farm.

In the spring of 1919, a test was started to show the value of soft phosphate rock, as compared with acid phosphate in supplying phosphoric acid to crops. From the first two pickings of cotton on this field this fall, acid phosphate appears to be giving better returns.

The experiments at this farm have brought out very strikingly the poor results secured in the growth of red clover without the use of lime. By supplying lime fairly liberally, and using a small amount of ferti-

lizer, it has been found, ordinarily, that one can be assured of a successful growth of clover; provided the seed are put in properly.

At the Buncombe Farm. In the regular fertilizer experiments on this farm, phosphoric acid, nitrogen, and lime seem to be the controlling constituents for the production of better crop yields, on both the bottom and upland soils.

With the rock phosphate tests, in which a comparison is being made of the value of this material, with acid phosphate as a source of phosphoric acid in crop growth, where both materials have been used, with stable manure and with legumes, the acid phosphate has given greater and more profitable yields under all conditions and with all crops, than has rock phosphate.

For the first few years at this farm the use of lime did not show up to be very beneficial. However, during the past two or three years the results are much more striking in showing the value of this material. Results show this material much more beneficial and essential for red clover and corn than for wheat.

At the Central Farm. Here the experiments have brought out very strikingly the importance of having more vegetable matter incorporated in the soil, so that crops will be enabled to take better advantage of the fertilizers which are applied. Nitrogen and phosphoric acid have given materially increased yields. The use of potash, in combination with these constituents, has been shown to be of little importance, as long as potash remains as high in price as it is at the present time. Certainly not until after nitrogen has been added in goodly amounts. It has been shown that a rotation simply of corn and cotton, without the use of lime, and using rye and crimson clover as winter cover crops, will not do very much alone for the improvement of the character of soils, as represented by those found at this farm.

A test was started this year to determine the relative efficiency of nitrate of soda and sulphate of ammonia as carriers of nitrogen for cotton, when applied on four different dates during the growing season. This test is planned to be conducted for several years before attempting to make any conclusions.

Experiments have been started, too, to study the value of phosphogerm and Trona potash as fertilizing materials.

Tobacco Experiments at the Reidsville Farm. The experiments with tobacco, to determine the best and most profitable combinations of fertilizer to use per acre, have been continued. From the results of the fertilizer experiment, the use of 800 to 1,000 pounds per acre of fertilizer containing about 8 per cent available phosphoric acid, and about 4 per cent ammonia, and 3 per cent potash is to be recommended for tobacco grown on the lighter soils. On those soils of the stiffer mulatto type, 600 to 800 pounds of an 8-3-3 fertilizer have been found to give good results.

At this farm a special series of potash plats is being conducted to determine the need of potash in tobacco growing. The results of this test bear out the evidence that previous year's work, with even quite small applications of potash, have a very favorable influence and profitable effect upon both the yield and quality of tobacco. It seems probable, from the data thus far secured, that, ordinarily, 2 to 4 per cent of potash in the fertilizer mixture will be sufficient.

The tobacco on the muriate plats during the year has looked slightly better than that which received sulphate of potash. The former seemed, too, to have been affected less by "sand-drown." A new feature of the work this year was the putting out of a special set of nitrogen plats, in duplicate, to test the comparative value of different sources of fertilization of tobacco. It is interesting to note that nitrate of ammonia (a product from the Muscle Shoals Nitrate Plant of the Federal Government) has given excellent results with tobacco. In the field tests the increased yields produced by lime have been noted. The tobacco, however, is somewhat coarser and darker where lime was used.

Here, as at the Granville Farm, a test is being carried on to determine the relative value of harvesting tobacco by priming and by cutting. In the rotation work with tobacco it is especially interesting to note the marked favorable effect of grasses.

A test has been made at this farm on the value of basic ferric sulphate for which considerable claims have been made as to its value. The result of one year's test does not indicate that it is valuable for the growth of tobacco.

In the study of crop relations or the inter-relations between fertilizers and crops, as they affect the crop producing power of the soil, it has been found that the cultivation of tobacco, as commonly grown and fertilized on land is not as exhaustive as is a crop of corn, ordinarily handled.

TOBACCO WORK AT GRANVILLE FARM

General Fertilizer Tests. In these tests there are thirty-six plats. Tests are being made of different sources of nitrogen, phosphoric acid, and potash for tobacco. These plats have now been going for nine years, this year completing the third cycle of rotations. The results have been very interesting, showing marked differences between the organic and inorganic nitrogen, also between the different combinations of these. Acid phosphate seems to be the best source for phosphoric acid applied under flue-cured tobacco, as the bone meal and basic slag do not mature the tobacco rapidly enough. Under present market conditions there is some evidence that muriate of potash may give good results, looking at it from the standpoint of the grower, but its use is not generally advocated, as it no doubt injuriously affects the burning qualities of the tobacco.

Special Potash Plats. Under these different amounts of potash, both muriate and sulphate, 12, 24, 36, 80, and 160 pounds per acre are used.

So far, the results have shown that from 36 to 40 pounds of potash per acre will show a profit even at a very high cost of material, as high as $1 per pound, but beyond that quantity it does not show the same profit.

Fourteen Plats Using Farm Manures and Tobacco Stems. The results from these tests have shown that good tobacco can be grown by the use of farm manure and hard wood ashes; and also from the use of tobacco stems and phosphoric acid.

Variety Tests of Tobacco. We have tested out a large number of so-called varieties, also a large number of distinct varieties, kept record of yield and color, and have tried to classify as many of these as possible. Up to this time no breeding work with tobacco has been carried on for the lack of time and help.

Rotations—Systems for Tobacco Farmers. We are working on two-, three, and four-year rotations for tobacco, using as many legumes as can be worked in, and have been able to get some results, but conditions on each farm change so much that we are not yet able to determine the best rotation to follow on the average tobacco farms of the State.

Tobacco After Cowpeas. By the use of liberal amounts of phosphoric acid and potash, combined with closer planting and higher topping, we have been able to grow 800 to 1,000 pounds per acre of fairly good tobacco. The usual trouble of leaf spotting and diseased tobacco has not yet been experienced, which frequently follows when tobacco is planted after cowpeas. However, this is not recommended as a very good rotation, as there are other troubles which often follow, viz., wire worm or, possibly, root rot.

Closer Planting Combined with More Intensive Fertilization. In this experiment 12 plats of one-twelfth acre each were used. From 450 to 1,000 pounds per acre of a 5-8-5 fertilizer were used, and from 18 to 36 inches in the row, 45-inch rows, with each of the different applications of fertilizers. The results thus far secured have been very gratifying. By closer planting and better fertilization the yield can be practically doubled and still maintain the quality. It is not recommended, however, as a general proposition, that farmers be advised to use more intensive methods, plant more tobacco on the land, and use more fertilizers.

Experiments in Priming vs. Cutting. These experiments have been discontinued after six years work. The results from four years work have been published in Bulletin No. 238 of the N. C. Experiment Station. About 75 per cent of the farmers of Granville County, and from 40 to 75 per cent of all those in the adjoining counties, have changed their methods of harvesting the tobacco crop from cutting the stalk to priming off the leaves as they mature, since seeing or reading of the results of this experiment. Our estimate, which is in accord with the estimate of a number of the best tobacco men of Oxford and the county, is that this one change in the method of harvesting the tobacco crop has saved the farmers, during the past three years, not less than three or four million dollars.

Permanent Tobacco Seed Beds. It is believed that a permanent seed bed, located at a convenient place, near water, etc., can be established and maintained indefinitely, provided the bed is thoroughly sterilized each year. This is being done at this farm by the use of steam, which has been found to be the most economical, as well as the best method of sterilizing seed beds.

Nutrition Work. In these experiments there are 126 plats being conducted in coöperation with the U. S. Department of Agriculture. These plats are seeded with different legumes, both winter and summer, and are then planted to tobacco, cotton, and corn, after which they are planted to rye, wheat, and oats. The results thus far secured are exceedingly interesting, and will be very valuable as soon as we can get enough data to safely interpret the results and make general deductions. The chief purpose of the experiments is to determine the best legume for each of the three main crops grown in the State, also to determine the residual effects. Ninety plats, under this same project, have now been conducted for four years to determine the effects on the three main crops—tobacco, cotton, and corn—also fifteen plats more as checks on both series, making a total of 231 plats under this project, alone.

In addition to the projects mentioned above, which represent 401 plats to be cared for each year, there have been conducted at the Granville Farm, in coöperation with the Office of Tobacco Investigations of the U. S. Department of Agriculture, a large number of tests in the laboratory for the past two summers, working on the different leaf-spot diseases, "sand drown," and various other nutrition troubles.

However, this is the only tobacco station that is operated on land owned by some permanent organization in the United States, and should therefore be put in the best shape possible to do tobacco work, as tobacco is one of our most important farm products in a financial way. It is true that there is other work on tobacco being conducted in other places, but this is being done mostly on land controlled by short term leases, and with little or no equipment.

In order to put the work in the most satisfactory working condition at this farm, more funds will have to be provided than have been available in the past.

PLANT BREEDING EXPERIMENTS

With Cotton at Central Farm. During the year the breeding work with cotton, with Adams funds, has consisted of a minute study of the plant characters of twenty-six strains of cotton which had been isolated from a strain of King's Improved. This season marks the sixth year that this study has been made. During this time, the strains have been reproduced by self-fertilized seed. Up to 1919 there was no perceptible decrease in the vigor of the different strains due to selfing, but this year there was some evidence of a lack of vigor. Whether or not this was due to external factors, it is impossible to say at this time. Self-fertilized seed have been secured again this year to compare with crosses

between several of the strain. The result by comparison of these crosses will help to indicate the effect of selfing for several years.

During the past two years the highest yielding strain has, on an average, produced 146 per cent greater yield in seed cotton than the lowest yielding strain. In a comparison of the size of bolls of the different strains, No. 43-54-5, the highest yielding strain, produced bolls which averaged 59 per cent more seed cotton than did No. 50-39-5, the lowest yielding strain. The average length of the lint of strain No. 43-54-5 has been 33⅓ per cent greater than strain No. 21-28-74, grown under the same conditions. In a comparison of the percentage of lint to seed, 43-54-5 has averaged 41.2 per cent, which is about 17 per cent greater than the percentage of lint produced by 13-33-5.

Effect of Locality Upon Characters of Cotton. In this work, a comparison of cotton plants grown from Mississippi and North Carolina seed of the same pure strain is being made in coöperation with the Mississippi Experiment Station. The original seed came, in 1914, from one self-fertilized plant of a uniform row in the plant-to-row breeding patch at the Central Farm, West Raleigh. One-half of the seed produced by this plant was supplied to the Mississippi Station and planted there; while the other half was planted at the North Carolina Station during the same season. The results secured in this coöperative work have been prepared for joint publication. The strain of cotton used in the experiment is still being grown, and kept pure in the two localities for the purpose of comparing seed from the two sources after several years growth. Arrangements were made this year for the extension of the work to include the Texas Experiment Station.

The results from the 1917-18 comparisons have shown that seed grown at the Mississippi Station, and brought to North Carolina and planted in alternate rows at West Raleigh, in comparison with seed of the same strain locally grown, have consistently produced taller plants which mature earlier. The difference in height has been noted from the time of blooming to maturity. Plants grown from Mississippi seed of this same pure strain have produced slightly heavier yields, a little longer staple, and are a little earlier in maturity.

CROP IMPROVEMENT WORK

With Cotton in Different Communities. During the past five years twenty-three communities in fourteen counties have received aid in improving their seed cotton for planting purposes. In each case, except one, the communities have been given a better variety than was locally grown up to the time the local test was made. At present, nine growers are improving their seed cotton by field selection and by systematic plant-to-row breeding. The men who are selecting seed, in coöperation with the Division of Agronomy, will have something like 4,800 bushels of improved cotton seed for sale this fall. Efforts are being made to induce the selling of as much of these seed as possible in the localities in

which they were grown. Practically all testing of varieties of different crops has been discontinued, except that which is being done in the community improvement work.

Community Improvement Work with Grains. In this work it is planned to handle corn, wheat, oats, and rye in the same way as cotton improvement work is carried on. Pure strains of each of these crops are now being increased at the Central and Iredell farms. Three communities of farmers have been started during the year in the improvement of their corn, and three have been organized in Gaston County for wheat improvement.

At the Buncombe Farm. On this farm Biggs Seven-ear corn is being selected for the two-ear type, and for increased yield per acre. Growers of the surrounding country are taking advantage of the good seed corn grown on this farm. In recent years the demand has been greater than the supply.

During the past season a small amount of pedigreed Haberlandt soybeans was grown for increase. The strain No. 38 was isolated three years ago from the ordinary Haberlandt. The improved strain matures ten days to two weeks later than the ordinary Haberlandt, and has been found to yield, when grown under the conditions existing on this farm, from six to ten bushels more per acre. This strain of soybeans should be to the mountain section of the State what the Mammoth Yellow variety has been to the coastal plain section. Four bushels of seed from this improved strain have been harvested this season. As soon as enough seed has been produced, it is planned to have this improved strain replace all others on this farm, and to produce each year a surplus of seed to be sold to farmers in the community. The work with soybeans has attracted considerable attention from farmers. The superintendent of the farm has had numerous calls for seed, and for information with reference to the best methods to follow in the growth and handling of the crop.

At the Iredell Farm. At this farm wheat, oats, rye, cotton, corn, and soybeans are being improved in a systematic way.

Each year a seed patch of strain No. 29 of cotton is grown and the best plants are saved for planting the seed patch the following year. At this time the strain is uniform in type and unusually productive when grown in this section. The farm should have between 75 and 100 bushels of seed of this strain to sell to farmers this year.

Beginning with this fall, the entire wheat crop on this farm was planted to a specially selected strain of Leap's Prolific. By next spring the improved Appler oats that are being grown will be sufficiently increased in quantity to plant all the oats on the farm to this specially pedigreed strain. Our pedigreed Abruzzi rye has also been sufficiently increased to plant the entire crop. The best crop of Abruzzi rye yielded at the rate of 26 bushels per acre this past spring, being considerably more per acre than was produced from wheat grown on adjoining land.

Weekley's Improved strain of corn for general crop planting is being kept up to standard by the growth of a seed patch each year on this farm.

During the past spring a small amount of Virginia soybeans, No. 11, was grown on this farm for increase. This strain was selected at the Central Farm three years ago. It has been found to be a high-yielding strain, and not to lodge as badly as does the strain of Virginia from which it came, and which is commonly found on the market. Five bushels of seed of the improved strain have been saved and will be used for increase purposes for distribution in the Piedmont section.

The plant improvement work with small grains at this farm has attracted the interest and favorable comment of visiting farmers. Visitors have been impressed with the superior yielding powers, purity, and uniformity of growth of the selected strains. The superintendent of the farm states that the selected strain of cotton used for planting the general crop is showing a marked influence on the yield and quality of the general cotton crop.

Rosin rye, which has been so extensively advertised in the central west, has not been found to produce satisfactorily on this farm. Abruzzi rye has been found to put out growth much earlier in the spring, and to be of a much more upright habit of growth than common rye. It has, therefore, been found especially suitable for seeding where winter and early spring grazing are of prime consideration.

At the Central Farm. On this farm seed improvement work is being carried on with cotton, corn, soybeans, wheat, and rye. The improved strain of King's Cotton, No. 29, is being kept pure and high yielding by selecting seed from the highest yielding plants, and by growing a seed patch with these seed each year. A selected strain of Mexican Big Boll made a yield of 1,450 pounds of seed cotton per acre, which had a 1⅛-inch staple. Next season it is planned to compare this strain with strain No. 29 of the King type, to determine the relative money value of the yields per acre of the two, in order to choose between the two for future growth on this farm.

A strain of Cocke's Prolific variety of corn is being improved by ear-to-row selection.

Our pedigreed Leap's Prolific wheat, No. 12, has been increased sufficiently to plant the entire crop on this farm this fall, and a portion of it has been used in three community tests out in the State.

One pedigreed strain of Abruzzi rye has also been increased sufficiently to meet the planting needs this fall.

Pedigreed strains of Mammoth Yellow, Virginia, and Haberlandt varieties of soybeans have been selected for increased yields. A portion of the best strain of Mammoth Yellow has been sent to the Edgecombe Farm for increase. One of the strains of the Haberlandt variety has been increased at the mountain farm, and the best Virginia strain, isolated here, has been sent, as mentioned above, to the Iredell Farm for increase.

At the Edgecombe Farm. At this time attention is centered at this farm on the improvement work with cotton and soybeans. Mexican Big Boll is the variety of cotton to which attention has been centered up to the present time. It has thus far proven to be earlier and much more uniform in quality than the original strain of Mexican cotton from which this strain came. If this farm could be equipped with a good gin, seed could be sold from the crop next year.

The strain of Mammoth Yellow soybeans, No. 101, being increased on this farm, was first isolated at the Central Farm three years ago. In comparison with the original strain last year, the selected strain yielded 7.7 bushels more per acre than did the variety from which it came. A pedigreed strain of Virginia soybeans, No. 12, is also being increased here.

In addition to the work indicated above for different farms, corn breeding experiments have been started recently at the Granville and Washington farms.

BREEDING SOYBEANS FOR HIGH-OIL CONTENT

The breeding of soybeans for high-oil content has been continued. The strains which have been found to produce the highest percentages of oil have thus far proven to be the poorest yielders. The largest quantity of oil per acre has been found to come from those strains which have yielded the largest quantity of seed per acre.

COOPERATIVE SMALL GRAIN WORK WITH THE U. S. DEPARTMENT OF AGRICULTURE

In these experiments a comparison of the growth and yields of wheat and oats is made, when planted at different dates and at different rates of seeding.

With wheat, the dates of seeding were October 1, October 15, November 1, November 15, and December 1. The rates of seeding on each of these dates were 30, 60, 90, and 120 pounds per acre.

With oats, the plantings were September 1, September 15, October 1, October 15, and November 1. The different rates of seeding on each of these dates were the same as for wheat.

These tests were carried on with Appler oats at the Iredell and Edgecombe farms, and with Fulcaster wheat at the Iredell Farm. In the test with wheat, during the year 1918-19, the November 1 date of seeding made highest yields of both straw and grain. According to previous tests, the October 15 planting should have stood first. The results from the past year may have been modified to some extent by seasonal conditions, the drouth during the past spring having done less damage to earlier maturing varieties and plantings. In all plantings with wheat, up to December 1, the 60-pound seedings have yielded best. A few of

the higher seedings produced slightly more than the 60-pound seeding, but the yield was not sufficient to warrant the use of the higher rate of seeding.

In the order of yield of seed, the oats ranked as follows during the past year: November 1, October 15, November 15, October 1, and December 1. Among the plantings made November 1, the 120-pound seeding yielded best. The seeding made December 1 did not germinate until the latter part of January. The seeding work with oats at the Iredell Farm showed November 1, during the past year, was the best date. Such results are unusual for this section, but are in accord with those secured with the wheat. The dates of planting ranked, according to yield during the past year, as follows: November 1, November 15, October 1, and October 15. With the exception of the November 1 seeding, late seedings have yielded best with the higher rates of seeding. The following is a list of the dates, with the rates which produced the highest yields of seed:

October 1	30 pounds
October 15	60 pounds
November 1	30 pounds
November 15	120 pounds

The best yield of straw was produced by the November 1 seeding. The November 15 seeding did not germinate until the latter part of January.

With oats, on the Edgecombe Farm, the November 1 seeding during 1918-19 gave best results. The oats, ranked according to yield per acre, as follows: November 1, October 15, November 15, and October 1. These results, as with wheat, are also contrary to the usual belief that early planted oats yield best. A closer examination of the temperature and precipitation of these two sections may throw light on the causes for the results during the past year. The rates of seeding of oats which yielded best on the different dates are:

October 1	60 pounds
October 15	30 pounds
November 1	90 pounds
November 15	120 pounds

The largest amount of winter-killing occurred on the November 15 seeding, while the October 15 planting showed the least amount of damage from this cause.

In closing, it may be said that the progress of the work of the Division has been due largely to the loyalty and fidelity to duty of those associated with the Division.

Respectfully submitted,

C. B. Williams,
Chief, Division of Agronomy.

REPORT OF THE DIVISION OF CHEMISTRY

To the Director:

It gives me pleasure to submit herewith a report of the Division of Chemistry for the year ended June 30, 1919.

The work of previous years has led to the conclusion that the toxicity of cotton seed is due to the presence of gossypol. In cottonseed meal this substance may be present in unchanged form; may be changed to a nearly related substance, which we have designated as D-gossypol; or may be changed to some other substance. The gossypol, itself, appears to be more toxic than either substance derived from it.

The work of the past year has been performed with the assistance of L. F. Williams, C. F. Miller, and S. J. Marion, members of the staff of the Chemistry Department of the college. For the coming year F. W. Sherwood has been appointed Assistant Chemist, and will give his entire time to the chemical work.

The results may be briefly summarized as follows:

(1) There is no evidence that gossypol or D-gossypol is left in the meal after extraction with ethyl ether and then with aniline, ether dissolving gossypol, aniline both of these substances.

(2) Analysis of the aniline-gossypol compound shows 73.74 per cent of carbon, 5.76 per cent of hydrogen, and 3.85 per cent of nitrogen, while analyses of aniline-D-gossypol show 74.81 per cent of carbon, 6.12 per cent of hydrogen, and 3.89 per cent of nitrogen. These figures, as well as the difference in the solubility in ether, indicate that these two substances are not the same compound.

(3) When aniline D-gossypol is heated to 140 degrees in the air it gains 0.71 percent in weight, while aniline gossypol, under apparently the same conditions, gains 1.96 per cent of its original weight.

(4) Cottonseed hulls have been found to contain 0.75 per cent gossypol, while the meats contain 0.70 per cent gossypol.

(5) Benzidine, aniline, phenyl hydrazine, (p) nitroaniline (p) toluidine, and alpha naphthylamine all produce precipitates, with the gossypol present in crude cottonseed oil, but that produced by aniline is the easiest to handle. This was done in connection with attempts to improve the method for the quantitative determination of gossypol.

(6) A mixture of phenyl-hydrazine and gossypol-free crude cottonseed oil becomes a solid mass of crystals, after standing a few days.

(7) Pure gossypol or D-gossypol does not form precipitates with benzidine, (p) nitroaniline, phenyl hydrazine, (p) toluidine, alpha napthylamine or urea in alcoholic solution.

(8) Free gossypol or D-gossypol in alcoholic solution, forms precipitates with the alcohol soluble proteins of either wheat flour or cottonseed meal.

This, perhaps, partially explains why heating reduces the toxicity of cottonseed meal, assuming that the gossypol or D-gossypol protein compound is not readily digested by the animal.

(9) In general, heating cottonseed meats to various temperatures in atmospheres of different gases, and in the presence of varying amounts of water, decreases the gossypol and sum of the gossypol and D-gossypol present, but increases the amount of D-gossypol content. The greatest effects are shown by oxygen and by carbon dioxide. The results obtained so far have not been consistent in all cases. This line of work seems to offer promise and will be followed up in order to determine the best conditions for mill operatives in order to produce a non-toxic meal.

Respectfully submitted,

W. A. Withers,
Chemist.

REPORT OF ANIMAL INDUSTRY DIVISION

To the Director:

Last year a statement of the investigational projects under way by the various members of the Animal Industry Division were given. Previous to that time, in the annual report I picked out some of the most outstanding features of the Division and reported these features in more or less detail. I will follow my old plan this year, as some have expressed a preference for the old plan. I cannot, of course, attempt to give in detail all of the work of the Division, but I will explain a sufficient number of projects to give a rather comprehensive idea of the work of the Division as awhole.

GENERAL SUMMARY

A general view of the activities of the various offices in the Division may be had from the following summaries:

Name of Office	*No. and Kind of Meetings*	*No. People Attending*	*Letters Written*
General Office (Gray)	1 community fair	320	1,296
	2 institutes	225	
Dairy Extension	2 opening of cheese factory	115	5,400
	3 farmers' institutes	105	
	1 farm life school	50	
	32 farmers' meetings (bull association and buying cows)	978	
	2 Holstein cow demonstrations	190	
	4 creamery stockholders	145	
	1 discussion milk situation	20	
	4 cheese factory annual meetings	117	
	2 promoting cheese factory	200	
	8 cheese factory organization	273	
	3 cattle improvement	130	
	1 directors' meeting	8	
	1 colored agents' meeting	20	
	1 general agents' meeting	100	
	1 butter-making demonstration	75	
	1 Convention Southern Cheese Men	20	
	1 State Dairymen's Association	30	
	1 location of site	65	
	1 distributing Holsteins	50	
Dairy Experimentation			1,248

Name of Office	No. and Kind of Meetings	No. People Attending	Letters Written
Swine Extension	2 club short courses	220	924
	2 farmers' institutes	170	
	1 picnic	175	
	1 farmers' convention	125	
	1 district fair		
	26 farmers' meetings (community)	714	
Swine Experimentation	1 South'n Agricultural Workers		525
Poultry Extension	372 school meetings	22,052	1,269
Poultry Experimentation	12 institutes	441	1,800
	6 poultry schools	243	
Beef Cattle and Sheep	57 demonstrations	1,425	9,463
	15 lectures	1,200	
	1 specialists' meeting	50	
	1 International	25	
	1 South'n Agricultural Workers	500	
	1 wool conference	200	
	1 specialists' meeting	25	
Total	574	30,801	21,925

OFFICIAL PUBLICATIONS BY MEMBERS OF ANIMAL INDUSTRY DIVISION

The members of the Division have not published as much literature this year as previously, but the public has been kept in touch with our various lines of work by means of circular letters, circulars, bulletins, and magazine articles. The following table gives the official publications of the Division during the last fiscal year.

Circular letters, 9 ..... *Curtis*
Circular letters, 1 ..... *Reed*
Circular letters, 14 ..... *Shay*
Circular letters, 1 ..... *Hostetler*
Circular letters, 1 ..... *Combs*

Circulars, 3:
- Beef Calf Clubs ..... *Curtis*
- Sheep Clubs ..... *Curtis*
- Beef Circles ..... *Curtis*

Circulars, 1:
- Score Card for Lard Type Hogs and Colony Hog House ..... *Shay*

Circulars, 1:
- By-products from Meat Curing ..... *Hostetler*

Circulars, 1:
- To Preserve Eggs for Winter Use ..... *Kaupp*

Bulletins, 1:
- Effect of Cottonseed Meal in Reproducing Animals ..... *Curtis*

Bulletins, 2 (posters):
- Sell Milk for the Cheese Factories—Get a Good Cow ..... *Reed*

Bulletins, 1:
- Results of the Guilford-Forsyth Cow-testing Organization ..... *Combs*

Magazine Articles, 13:

Cottonseed Meal as Poultry Feed. Jour. of Inst. & Inv. in Poultry Husbandry ..... *Kaupp*
Abnominal Purulant Condition of the Hen. Jour. Assn. of Inst. & Inv. in Poultry Husbandry.
Sarco-Chrondo-Osteomata of a Hen. Jour. A. Vet. Med. Assn.
General Sarcomatosis of the Fowl. Jour. Assn. of Inst. & Inv. in Poultry Husbandry.
Tendonitis and Periostitis Resulting from Injury by a Celluloid Spirolet Leg Band. A. Vet. Jour.
The Rationing of Poultry. Poultry Item.
Physical Characters Which Correlate with Egg Production. Poultry Item.
Plan of Production of Pedigreed Birds. Poultry Item.
The Three Stages in Handling Poultry. Poultry Item.
Two Years from Purebred Poultry to Mongrels. Poultry Item.
How the Chic Grows in the Shell. Poultry Item.
A Successful Small Commercial Flock. Poultry Item.
The Cost of Keeping a Flock of Fowls Now and 30 Years Ago. Poultry Item.

Books:

The Anatomy of the Domestic Fowl. Pub. Philadelphia and London. *Kaupp*
Poultry Culture, Sanitation, and Hygiene. Pub. Philadelphia and London. *Kaupp*

SWINE EXPERIMENTS

Our swine experimental work is now in direct charge of Mr. Earl Hostetler, who is devoting all of his time to it. As outlined at the present time this work is being done at the Central Experiment Station at Raleigh, at the Edgecombe Test Farm, and at the Iredell Test Farm. On account of the smallness of the Pender Test Farm and the encroachment of the horticultural work upon our space, it was necessary to discontinue all hog work at that place. This was done October 1, 1919.

The Value of a Mineral Mixture in a Hog's Ration

(Central Experiment Farm)

All of us have felt that we appreciate the value of minerals in the hog's ration, but the results of some experimental work we are doing seem to indicate that we have never valued this part of the ration as highly as it deserves. The National Hog Remedy Co., of Raleigh, N. C. had a representative to call upon us and ask us to conduct some feeding experiments to determine the value, if any, of their mixture which goes under the name of the National Hog Remedy and Liver Regulator. This led us into the study of mineral mixtures as supplements to grain mixtures.

On December 18, 1918, fifteen pigs were purchased for the first of these series of experiments. As the above company claimed that their mixture removes intestinal and kidney worms, pigs were selected which were known to be badly infested with worms. The pigs were divided into three equal lots, the first lot being fed a ration made up of one-half corn, one-fourth wheat shorts, and one-fourth peanut meal. The second

lot of pigs was fed a similar ration both as to kind and amount, and the ration was supplemented with a home-made mineral mixture. The third lot of pigs was fed a similar ration, supplemented with the National Hog Remedy and Liver Regulator. The experiment continued through March 16, 1919, a period of 88 days. Each pig in the first lot gained daily .47 of a pound, each pig in the second .68 of a pound, and each pig in the third lot .70 of a pound. When corn is valued at $2 per bushel, wheat shorts at $64 per ton, and peanut meal at $70 per ton it cost $24.96 to make one hundred pounds of increase of live weight in the first lot where no mineral mixtures were used, $16.38 in the second lot where the home-made mineral mixture was used, and $16.36 in the third lot, where the National Hog Remedy and Liver Regulator was used. It should be stated, however, that these mineral mixtures used in the first experiment played an active part in removing the worms from the intestinal tract and from around the kidneys, but as the second experiment is just being closed, the report of this part of the work is withheld until a post mortem examination is held on the second lot of pigs.

The mineral mixture used was made up of:

Crushed charcoal	10 pounds
Air-slaked lime	5 pounds
Salt	4 pounds
Sulphur	2 pounds
Copperas	3 pounds

The second experiment was begun June 14, 1919, and closed November 3d, covering a period of 142 days. The first three lots in this experiment were fed exactly the same amount of grain, notwithstanding the fact that the two lots receiving the mineral mixtures would have eaten very much more grain than the first lot, which ate grain alone. The last two lots, four and five, were fed all of the grain they would eat in addition to the mineral mixtures. The pigs in lot one were fed a ration made up of one-half corn, one-fourth wheat shorts, and one-fourth peanut meal; these pigs gained daily .33 of a pound at a cost of $23.76 per hundred pounds. The second lot of pigs was fed a similar grain ration plus a mineral mixture like the one used in the first experiment; these pigs gained .43 of a pound daily at a cost of $18.22 per hundred pounds. The third lot of pigs was fed a grain mixture equal to that in the second lot plus the National Hog Remedy and Liver Regulator; these pigs gained daily .42 of a pound at a cost of $19.02 per hundred pounds. The fourth lot of pigs ate all of the grain mixture they wanted, plus the home-made mineral mixture; these pigs gained daily one pound at a cost of $16.74 per hundred pounds. The fifth lot of pigs ate all of the grain mixture they wanted plus the National Hog Remedy and Liver Regulator; these pigs gained daily 1.15 pounds at a cost of $17.10. At this writing post mortem examinations have not been held, so we are not ready for this part of the report.

Fish Meal Against Tankage as a Feed for Hogs

(Central Station)

During the last two years many inquiries have come to us relative to the value of fish meal as a feed for hogs when used in conjunction with corn. The value of tankage is so well known that we thought it would be well to compare fish meal directly with tankage. Consequently, an experiment was outlined and begun April 23, 1919, to determine the relative value of these two meat products. The first experiment was closed August 20, 1919, so the experiment continued 119 days. The pigs were divided into two lots, the first lot being fed a ration made up of nine-tenths shelled corn, plus one-tenth Digester Tankage, while the second lot had fish meal substituted in the place of tankage. The average daily gain was almost the same. The tankage-fed pigs gained .95 of a pound each daily, while the fish meal fed ones gained exactly one pound each, daily. When shelled corn is valued at $2 per bushel, tankage at $110 a ton, and fish meal at $100 per ton, it cost $20.10 to make one hundred pounds increase in live weight in the tankage-fed lot, and $18.86 to make an equal increase in live weight in the lot where fish meal was used. This experiment would seem to indicate, therefore, that fish meal has an important place to fill in a hog's ration.

Curing Meat on the Farm

(Pender Test Farm and Central Experiment Farm)

We are doing no little amount of work to determine the best methods of curing and smoking meat under farm conditions. In this study we are determining the shrinkage in meat during the curing processes, shrinkage of meat when made from meat of hogs which have been fed upon different rations, and shrinkage of meat when cured by various patent processes, and the effects of feeds and patent processes upon the keeping of the cured meats. Almost all of this work is being done at the Central Farm as it requires the constant attention of Mr. Hostetler. The manufacturers of patent liquid smoke usually claim that the shrinkage of meat is very much less under their treatment than when hickory smoke is used. This year the meat cured by the liquid smoke method shrank 13.9 per cent in weight, while that cured by the hickory smoke method shrank 14.9 per cent in weight. We have accumulated results for five years, and the average shows that the shrinkage when liquid smoke was used was 12.7 per cent, while the shrinkage when hickory smoke was used was 12.9 per cent. The claims of the manufacturers of liquid smoke are not, therefore, justified.

Packers usually make the claim that meat made from hogs which have been fed upon soybean and peanut pastures shrink very much more during the process than meat cured from hogs fattened upon corn alone. In fact, this is one of their main arguments for discriminating against soft-bodied hogs. Our results for the past several years do not bear out

the packers' charge. In our work meat cured from hogs which never had peanut or soybean pasture shrank 19.4 per cent; cured meat from hogs which were grazed upon soybeans shrank 20.6 per cent; meat made from hogs fattened upon peanut pastures shrank during the curing process 16.9 per cent.

Arrangements are made to enlarge very materially our capacity for studying such problems as these in the future.

Grazing Crops and Soft Pork

(Edgecombe and Central Test Farms)

Mr. D. M. McCarty, chemist for the Animal Industry Division, secured leave of absence and enlisted in military services at the beginning of the war. It has been impossible, therefore, for us to take care of the chemical part of the soft pork studies. We have, however, preserved samples from all of the animals and will be ready for the chemical work just as soon as another chemist can be secured. Unfortunately for us, Mr. McCarty is not coming back, as he has decided to farm in Mississippi. We hope, however, to get a good chemist within a short time.

We have continued the study of the problem to determine the relative value of peanuts and soybeans, and also to determine just how much grain, if any, should be used as a supplementary ration to these pastures. This year one experiment began October 10th, and continued until December 6th. During this time the lot of pigs in the dry lot were fed upon a ration made up of two-thirds corn, and one-third wheat shorts, and gained daily .32 of a pound at a cost of $35.25 per hundred. The second lot of pigs was fed a similar ration in conjunction with soybean pastures; these pigs gained daily .46 of a pound at a cost of $22.39 per hundred. The third lot of pigs was fed upon soybean pastures alone; these pigs gained daily .41 of a pound at a cost of $20 per hundred. The fourth lot of pigs was fed peanut pasture alone; these pigs gained .62 of a pound at a cost of $23.80 per hundred. The pastures were very poor, as the cost of gains would indicate. In the above financial statement, corn is valued at $2 per bushel, wheat shorts at $58 per ton, and pasture at $20 per acre. The primary object of this study, of course, is to get samples of lard to determine the effect of these feeds upon the bodies of the animals. These samples were secured and will be studied just as soon as a chemist is located.

The second experiment was conducted at the Pender Test Farm, to study further the relative value of soybean and peanut pastures. This test was under way from October 28th to December 19th, a period of 52 days. The pigs in the first lot were fed a ration made up of two-thirds corn, plus one-third wheat shorts; these pigs gained .46 of a pound daily at a cost of $25.71 per hundred. The pigs in the second lot were fed a half ration of corn and shorts as a supplement to soybean pasture; these pigs gained .46 of a pound daily at a cost of $25.50 per hundred.

The third lot of pigs was fed a similar grain ration as a supplement to peanut pasture; these pigs gained .9 of a pound daily at a cost of $13.43 per hundred. Samples of lard were also taken from these animals and will be preserved for the chemist.

We are continuing the investigation relative to the value of bur clover pasture as a grazing crop for pigs during the spring months. This year the grazing continued from March 28 to May 15th, a period of 48 days. One bunch of pigs was maintained in a dry lot upon a ration made up of two-thirds corn plus one-third wheat shorts; each pig gained .17 of a pound daily on a grain ration of 1.89 pounds each. The pigs in the second lot—17 on one acre of bur clover—gained .17 of a pound daily on a daily grain feed of 1.03 pounds each. Each acre of bur clover, therefore, saved $21 worth of grain, and did this in 48 days.

We have recently inaugurated some work at the Edgecombe Test Farm to determine the exact value of permanent pastures when used as grazing areas for hogs. The first test was inaugurated May 27th and continued to September 16th, a period of 112 days. The first lot of hogs was fed in a dry lot on a ration made up of two-thirds corn plus one-third wheat shorts; these pigs ate daily 2.94 pounds of grain and gained .42 of a pound daily. The second lot of pigs was fed a similar but smaller ration of grain as a supplement to the Bermuda pasture; each one of these pigs ate daily 2.46 pounds and gained .41 of a pound. An acre of Bermuda therefore saved, during the 112 days, $9.03 worth of grain, when corn is valued at $2 per bushel and wheat shorts at $60 per ton. This study is to be continued for a number of years.

POULTRY INVESTIGATION

Dr. Kaupp, who has charge of this office, is assisted by Mr. Ivey and Mr. Warden. As in the past, his work has consisted almost entirely of investigational work, but he does a small amount of extension work when a phase of extension activity comes up that cannot be handled by the regular extension men.

COOPERATIVE COMMERCIAL WORK

During the war Dr. Kaupp was called upon by some of our neighbors to assist in commercial enterprises. He always did this whenever the one asking the assistance agreed to place the business upon such a basis as to give him financial and other results. This sort of work was carried on with Mrs. Jesse Earnshaw of Wake Forest, N. C., in an undertaking to grow baby chicks; with Mr. L. J. Banzet of Ridgeway, N. C., in an undertaking where the selling of eggs was the main product; with Mr. M. Lienn of Apex, N. C., with a small undertaking; with Mr. C. P. Wharton of Raleigh, N. C., in a city back lot enterprise, and with others. Dr. Kaupp, through these efforts, was able to be of material assistance to some farmers, and gained a lot of commercial information which has been of assistance to him in his educational campaigns.

EXPERIMENTAL WORK

The investigational work done by this office is divided into two heads. Dr. Kaupp is a pathologist, so he necessarily devotes much of his time to pathological studies. The rest of his time is devoted to feeding and nutritional studies.

A. PATHOLOGICAL STUDIES:

The specimens coming to the laboratory determine in a measure the kind of pathological work done. During the year he has had occasion to study further cases of white diarrhea in chickens, liver and kidney troubles, diseases of the reproductive organs of the hen, diseases of the lungs of fowls, diseases of the shell glands, tumors of the ovaries, bleeding combs of hens, and other pathological studies. Almost all of these studies have been reported in the scientific journals of this and other countries.

B. FEEDING AND NUTRITIONAL WORK:

(*a*) *Cost of Raising Chicks.* We raised twenty flocks of chicks at the Central Plant during the past year, and kept an exact count of the feed eaten and cost of the feed, and the weight of the chicks at various ages. The average weight at the end of eight weeks was .82 of a pound. It required an average of 3.2 pounds of grain and 3.2 pounds of buttermilk to produce a pound of gain. At prevailing prices of feeds the cost of the feed was 20 cents a pound, which represents about 50 per cent of the total cost of raising chicks during 1919.

(*b*) *Breeding Work with S. C. White Leghorns.* This work is now entering its sixth year. The flock with which we started laid an average of 89 eggs. These hens, known as lot 1, were bred the first year to common cockerels and produced lot 2. The hens in lot 2 laid an average of 92 eggs per year as an average for three years. The hens in lot 1 were then mated to good cockerels and produced the lot of hens called lot No. 3. The hens in lot No. 3 have laid an average of 135 per year for the first two years. This seems to show that high fecundity is transmitted from sire to daughter, although this is sometimes denied by poultry breeders. To determine if high fecundity is transmitted from the sire to the son and the sire to the daughter, brothers of the pullets in lot No. 3 were mated to lot No. 2, and these offspring laid an average of 112 eggs per year for the first year. In addition to studying some of the scientific principles of breeding work, we are developing a flock of hens which are high egg producers. This principle is being applied to the flock of Rhode Island Reds and to the third flock of Barred Plymouth Rocks.

(*c*) *Effect of Temperature, Sunshine, and Barometric Pressure on Egg Production.* Full records are being kept of temperatures, sunshine, and barometric pressure, and these are studied in connection with the number of eggs produced by the various flocks. Long rainy spells regu-

larly depress the egg-laying capacity of flocks. In one long rainy spell the flock dropped 50 per cent in egg yield. The number of hours of sunshine has a bearing on the number of hours the chick can eat, and the number of hours she can eat has a direct bearing upon what she will produce. With this thought in mind, a coöperative experiment has just been put under way with the Manitobia Agricultural College so that we may determine just what influence the number of hours sunshine has upon the egg yield. It may be that the south has a peculiar advantage in this respect.

(*d*) *Does Turning of Eggs Affect the Hatching Qualities?* A number of eggs were set aside for this work, half of the eggs being turned once a day, while the other half was allowed to remain in one position in the box. Four hundred eggs were used in the test, and the result of four tests does not seem to teach that the turning of eggs has anything to do with their hatchability. This is contrary to common opinion, but seems to be true nevertheless.

(*e*) *The Relative Value of Proteins in Growth and in Egg Production in S. C. White Leghorns.* This experiment was outlined to study the value of the sources of protein. The sources of the proteins are found in buttermilk, meat scrap, dried blood, Digester Tankage, soybean meal, and peanut meal. The studies so far lead us to make the following statements:

Birds grow off rapidly with blood meal, and the mortality is less than with any other protein carrier used. At the end of the sixteenth week the chickens raised on buttermilk weighed slightly more than those raised on any other protein carrier. Although the lot receiving blood meal began to lay earlier than any of the others. The first period of this experiment will be concluded October 31, 1920, when a detailed report will be given to the public.

(*f*) *Skim Milk in the Ration for Raising Chicks.* At the Iredell Station a study is being made to determine the value of sour skim milk in the ration for chicks. One lot of chicks is fed a ration made up of corn meal, ground oats, soybean meal, and meat meal. The second lot is fed the same grain ration as supplement to sour skim milk. During this year the chicks in the lot receiving skim milk weighed 1.32 pounds each when eight weeks old, and 3.7 pounds each when sixteen weeks old. Each chicken in the lot where no skim milk was fed weighed at the end of eight weeks .7 of a pound, and at the end of the sixteenth week 2.9 pounds. At the Edgecombe Test Farm a similar study was made, only the grain ration was made up of corn meal and peanut meal. One lot of chickens was fed a grain mixture as a supplement to sour skim milk, and each chicken at the end of eight weeks weighed .91 of a pound, and at the end of sixteen weeks 3.45 pounds. Each chicken in the lot where no skim milk was used weighed .87 of a pound, and at the end of the sixteenth week weighed 2.07 pounds.

(*g*) *Value of Velvet Bean Meal in the Ration for Growing Chicks.* Six separate experiments have been conducted during the year to determine the place of velvet bean meal in the ration for growing chicks and for fattening older birds. Satisfactory results have not been secured in any case. In fact, it seems to be injurious, and we have about concluded the injurious material may be in the pod. Peanut meal is satisfactory. Further studies will be made.

(*h*) *Mineral Requirements for Growing Birds.* One of the most important problems under study by Dr. Kaupp is the one having to do with mineral requirements of growing birds. The first publication of the results is now in press. A summary of this publication may be stated as follows:

1. It is noted in the analyses of the bodies of birds at different ages in their life, beginning when first hatched, that as the bird grows larger that the quantity of calcium, magnesium, and phosphorus is increased. As the bird grows there is a greater proportionate amount of bony structure. There is also an increase of sulphur, due to the fact that as the baby chick grows its downy coat is changed to a coat of feathers. There is also an increase in chlorine.

2. In these studies seventy-three complete mineral analyses of feeds were made, besides analyses of excreta.

3. In the first tests the experimental birds were given grain mixtures consisting of oats, corn, and wheat. The mash contained wheat middlings, bone meal, meat and bone meal, and corn meal. In addition, they were given all the sour skim milk they would drink, finely cut green feed in the form of rape, also oyster shell and limestone grit. In a study of the balances from the table of intake and outgo, there appears ample potassium, sodium, calcium, sulphur, chlorine, and iron, but a slight deficiency of magnesium and phosphorous.

4. Feed mixture 1 has a nutritive ratio of 1:3.2; 3, 1:2.2; 2, 1:7.4; and 4, 1:7.6, which, from a protein carbohydrate standpoint, should be ample. It contained approximately a mineral balance. There was required to produce one pound of gain 2.91 pounds grain and mash, 7.49 pounds sour skim milk (reduced to dry matter would be 0.74 pound), or a total of 3.75 pounds feed.

5. The feeds here studied which are richest in calcium are oyster shell, limestone grit, soybean meal, velvet bean meal, meat and bone meal, bone meal, and eggs in shells. Those richest in magnesium are oyster shells, limestone grit, peanut meal, soybean meal, velvet bean meal, meat and bone meal, bone meal, and wheat middlings. Those richest in phosphorous are eggs in shells, peanut meal, soybean meal, velvet bean meal, meat and bone meal, oats, bone meal, wheat middlings, corn, and wheat. Iron does not appear to be deficient in most feeds. Chlorine is most abundant in eggs in shells, velvet bean meal, and in meat and bone meal. Sodium is most abundant in eggs in shells, peanut meal, soybean meal,

meat and bone meal, bone meal, and wheat middlings. Most cereals and their by-products are deficient in chlorine, sodium, and calcium. Potassium does not appear to be deficient in any of the feeds.

6. Feed mixtures, such as grains and their by-products, need such feedstuffs as meat scrap, bone meal, meat and bone meal, milk, and oyster shell and limestone grit, with one per cent sodium chloride to make good the deficiency in phosphorous, magnesium, calcium, chlorine, and sodium. Of the vegetable products both soybean meal and peanut meal are particularly rich in sodium, potassium, and magnesium. The excellent results which have been obtained by these two feeds are, in part, due to this fact.

7. In feed mixtures 5 and 6 we have introduced the most simple mixtures which have given very gratifying results in those tests where these feeds were given with milk. There is here a fair amount of the most vital minerals, besides essential amino acids, the only mineral deficient is chlorine, which can be compensated for largely by adding three-fourths per cent sodium chloride. These mixtures consist of but two feeds, viz., corn meal with, in the one case, soybean meal, and in the other, peanut meal. In mixture 7 the mineral and protein deficiencies are compensated for by the meat and bone meal. It would be expected that better results would be attained by mixture 8, which has, in addition to the fat extracted, soybean meal, bone meal, and meat and bone meal. Ground oats is added in mixtures 9 and 10, which no doubt adds to the palatability and lends a greater variety.

8. Mashes or ground feed mixtures are essential in chick raising to furnish sufficient mineral salts, which are essential for proper growth. In tests with feed mixtures 5 to 10, the chicks were allowed the run of the grassy yards and were not given grain mixtures. The mortality was not greater than other tests where grain mixtures were fed. It is not essential to give grain mixtures where chicks run at large and can secure bugs, waste grain, and other feeds.

9. In nine flocks of Single-comb Rhode Island Red chicks given mixture 7, with milk and with milk to drink, the average weight per chick at the age of eight weeks was 1.33 pounds, while eight flocks given the same feed, but did not receive milk, averaged 1.15 pounds each. The milk lot averaged 13 per cent greater in weight than the water lot. This difference in weight is due partly to the increased mineral required. The fat remaining in the skim milk furnishes needed fat soluble vitamine, and the milk also contains suitable proteins.

10. Nine flocks of Buff Plymouth Rock chicks were given mixture 10, with milk and with milk to drink. These birds averaged, at the end of eight weeks, 1.30 pounds, while four flocks given the same mixture, but no milk to drink, averaged but 0.88 pounds each. The milk lot averaged 47 per cent greater in weight than the water lot.

11. Twenty-two flocks of White Plymouth Rock chicks were given mixture 9, with milk and milk to drink, at the end of eight weeks these

chicks averaged 1.03 pounds each, while five flocks given the same feed, but no milk, averaged 0.65 pounds each. The milk lot averaged 58 per cent greater in weight than the water lot.

12. The results thus far show greater development in those birds receiving nearer the required amounts of mineral matter. These are the ones receiving animal feeds, as bone meal, meat and bone meal, meat scrap, or milk, together with green feed and crushed oyster shell and limestone grit.

BEEF CATTLE EXPERIMENTAL WORK

(*a*) *Effect of Cottonseed Meal on the Reproductive Ability of Cows.* This is one of the most important and extensive pieces of investigational work being done. It is being conducted by Messrs. Curtis and Combs at the Central Test Farm at Raleigh. This work was started several years ago on a small scale, but has been recently materially enlarged. The plan of the work calls for five lots of animals, the last lot of which is to receive no cottonseed meal at all, and the other lots to receive various amounts of cottonseed meal. A record is being kept of the breeding qualities of all of the animals. An experiment of this kind will necessarily be continued for a number of years, as the offspring of the cows are to be kept and fed just as the mothers are fed. The work has not continued long enough as yet for definite results to appear.

(*b*) *The Effect of Various Roughage Feeds on Retarding the Toxic Effect of Cottonseed Meal in Sheep.* Cottonseed meal is a standard feed of the South, and is well suited to sheep. An experiment was therefore planned to determine whether it can be fed continuously to breeding ewes without ill results. During the summer the sheep are maintained on pasture. During the cold months they are divided into two flocks, one of which is fed cottonseed meal with dry roughage, and the other flock cottonseed meal with succulent roughage. This work has been conducted for four seasons, and up to date no detrimental results have been experienced when as much as two-thirds of a pound of cottonseed meal was fed to each animal daily. There are some indications, however, that cottonseed meal does cause ewes to lamb somewhat early. This may, however, be merely a coincident.

(*c*) *Study of Milk Sickness or Trembles.* The progress and results of this work were published fully in Technical Bulletin No. 115. There are additional phases to be studied, but the war situation delayed pursuing these studies. It is hoped, however, that we may get back to them the coming spring. Plans are made now to demonstrate the usefulness of the results of this research in two or three places in the mountains.

(*d*) *Wintering Stockers and Feeders in the Mountains of North Carolina.* This coöperative work with Mr. T. L. Gwyn of Haywood County is progressing satisfactorily. The past year, from December 12, 1918, to April 17, 1919, five carloads of cattle were used in the experiments. Briefly, the results show that cattle wintered on hay, corn

silage, winter pasture, stover, and straw winter approximately equally well. The cost of wintering varied from $5.52 to $11.88, depending upon the ration used. The cattle in the lot on winter pasture only cost approximately one-half as much as those which were wintered on grains and roughages. All results, as in the past, are very much in favor of the development of winter pastures in the mountain territory.

(*e*) *Residual Effect of Winter Feeding on Subsequent Summer Gains on Pasture.* This work is also being done with Mr. T. L. Gwyn, and is really a continuation of the winter work reported above. The same five carloads of cattle were used, being carried on pasture from April 17, 1919, to September 3, 1919. When the summer and winter work are combined, the results show directly the value of winter pasture. The total cost of the cattle which were carried on pasture both winter and summer was $6.36 less per head than the cattle which were fed during the winter months on hays and other roughages. When winter and summer pastures are taken together, our results have always been in favor of this combination.

DAIRY EXPERIMENTATION

During the year Mr. Combs has devoted much time to tabulating the data previously secured, and getting it ready for publication. Early in the year Bulletin No. 249 was published, giving the results of the Guilford-Forsyth Cow Testing Organization.

COST OF MILK PRODUCTION

In July, 1915, we began a study in coöperation with the authorities of Washington to determine the cost of producing milk upon typical North Carolina farms. The study was made in and around Greensboro, Mr. Combs being in charge. The work closed some time ago, and Mr. Combs has spent much time in getting together this voluminous mass of material for publication. It is ready for publication now, and very much valuable information is coming from the effort. A brief summary of the bulletin shows that the following amounts of labor and feed were required to produce one hundred pounds of milk (it should be remembered that this is an average of more than a dozen herds maintained under farm conditions).

52.9 pounds concentrates.
56.8 pounds dry roughage.
132.4 pounds succulent feed as silage.
11.2 cents worth pasture.
.4 cents worth bedding.
3.4 hours human labor.
1.8 hours horse labor.
55.0 cents overhead cost for production and distribution
51.7 cents credits other than milk.

When grains are valued at $70 per ton, dry roughage at $40 per ton, silage at $10 per ton, human labor at 35 cents an hour, and horse labor

at 20 cents an hour, it cost these farmers just about 60 cents a gallon to produce and deliver their milk. This is perhaps the most accurate information ever secured on the cost of producing milk under actual farm conditions.

EXPERIMENTAL CHEESE WORK IN WATAUGA COUNTY

Early in the spring the Cove Creek Cheese Factory asked the Dairy Experimental Office to determine whether or not a whey separator could be profitably used under their conditions. Mr. Combs secured the loan of two standard machines, installed them in the factory, and spent the greater part of August supervising the investigation. He found that he was able to recover from eight to nine pounds of cream from each two thousand pounds of whey. The labor required to run the whey through the separator amounted to about one hour a day. As the cost of the separator is just a little over $400, he concluded that the machine was practical. The factory therefore decided to purchase a machine and install it for permanent use. It is expected that this will spread to the other cheese factories in the mountains.

PENDER HERD

Before undertaking dairy investigational work with the milking cows in the Pender herd, Mr. Combs decided to set aside a year to develop the herd along breeding lines, and get as many cows as possible in the Register of Merit. During the past year he has succeeded in qualifying fourteen cows, and others are on the Register of Merit test. I have before me now the milk yield of eleven of these cows, the average being 7,413.5 pounds. The average yield of the whole herd the past year has been considerably over 6,000 pounds. There is no reason why this yield, although it is a good one, should not be materially raised during the next year, as several more cows are coming into milk soon. Just as soon as Mr. Combs has developed the individuals of the herd a little further and becomes personally acquainted with the individuals, he expects to undertake our old lines of careful investigational work with them.

Respectfully submitted,

DAN T. GRAY,
Chief, Animal Industry Division.

REPORT OF THE DIVISION OF ENTOMOLOGY

To the Director:

I submit report on the operations of this Division on investigation projects for the year 1919. The year has been one of unusual activity. For several years we have made only brief reference to many projects,

but now we are able to refer to some published results, and to say that others are so far advanced that publication already is, or soon will be, justifiable.

POTATO SPRAYING

With Late Potatoes. This work with late potatoes has been conducted at the Mountain Branch Station by Mr. R. W. Leiby, with the valuable coöperation of Mr. S. C. Clapp, superintendent of the farm. The sixth year of this work has been completed. The past year showed a gain of 53 bushels per acre, or 49 per cent, by spraying with the home-made poisoned Bordeaux mixture, prepared and applied after the manner which we have long recommended.

Bulletin No. 254 of the State Department of Agriculture (March, 1919), prepared by Mr. Leiby, gives the complete tabulated results of five years work on this project. This bulletin has been widely distributed, not only through the regular mailing list, but also to a special list of commercial potato growers, which we worked up for the purpose, in advance of publication. As far back as 1917, we were seeking names and addresses of potato growers—to these a preliminary circular on the subject was sent (Extension Circular No. 48), and they have now been supplied with the complete bulletin.

A very brief tabulation from the summary of results set forth in the bulletin follows:

POTATO SPRAYING—LATE CROP

Average of 5 years experiments, on basis of 1 acre.

Treatment	Yield (Bushels) per Acre	Per Cent Gain per Acre	Net Money Gain per Acre (Deducting Costs)
1. Check—no control of pests	89.90		$
2. Hand-picking of beetles	98.50	.95	4.82
3. Bordeaux mixture without poison	124.90	39.00	33.22
4. Poisoned Bordeaux (home-made)	141.50	57.50	47.17

With Early Potatoes. The second year of experiments in the eastern part of the State with spraying and dusting has been completed. Tests were made at New Bern, Wilmington, and Mount Olive. Increases varying from 50 to 191 per cent were secured; but as the experiments are expected to run for several years, we would prefer not to publish any elaboration of the results at this time.

LARGER CORN STALK-BORER

The fifth year of work on this has been completed. The data secured on the life history and control of the pest are now sufficiently full to justify publication. They have been assembled in manuscript form with numerous illustrations.

Experiments show that the mortality among the over-wintering borers is greatly increased by plowing the stubble in the autumn. Injury is further reduced by planting May 25th, or later, as corn planted after (about) this date is attacked by only one generation of the borers, while that planted earlier is subject to attack by two generations.

DUSTING OF LATE CABBAGE

This work has been under way for three years, and it is found that weekly dusting with arsenate of lead and air-slaked lime in the proportion of 1 to 8 will control cabbage worms:

	Per cent of Plants Maturing Heads
1. Checks, not dusted	28 per cent
2. Dusted, weekly	75 per cent

We figure that an expenditure of about $6 per acre in this work brings an increased return varying from $50 to $175 per acre in value of product, according to the market.

PECAN INSECTS

This comprehensive project, involving the study of many different insects, has already been well advanced by Mr. Leiby in previous years, and is gradually nearly the point where publication will be justified. The work on this project this year was hampered by the intrusion of new issues.

FIELD STUDIES OF BLACK CORN WEEVIL

This pest has not been especially serious during the year. We continue, however, to note the field conditions which have a bearing on the pest and its control. We have lately seen a single corn-house in this State holding about 25,000 bushels of corn, virtually surrounded by thousands of acres of growing corn. It can be imagined what the weevil problem might amount to in such cases. Hence, every factor in growing, handling, or harvesting the crop previous to final storage, which might influence the number of weevils, becomes important.

INSECT SURVEY

This Division is increasingly impressed with the value of work on this project. Begun 19 years ago, without special reference to its economic bearings, and continued through the years for the sake of the greater grasp and understanding which it gives of the whole group of insect forms, again and again helpful preliminary data on important economic species in our card-records have been found, and data supplied to workers in other states or in the Federal service, on insects whose occurrence, or range, was in doubt. Preliminary data on the worm in soybeans was a recent conspicuous example.

During the year 1919 (to November 20th), 147 species of insects not before known to occur have been listed from the State, bringing the total State list to 5,191 species. The time has fully arrived for the engagement of a skilled worker upon this special project.

GREEN CLOVER WORM ON SOYBEANS

This was a new project of the year 1919. There was a very severe outbreak in July and August, involving thousands of acres. The injury was greatest in the eastern half of the State. A search of publications revealed nothing that could meet the situation. Investigations of intensive character were at once begun at two field stations, at Terra Ceia, by Mr. Leiby, and at Elizabeth City, by Mr. Sherman. Our studies on life-history confirmed much that had been published by others, and yielded much original data of our own. The work on control showed the use of poisons to be effective and more practical than had been supposed; especially when the crop is grown in rows. Dusting with dry arsenate of lead, mixed with dust lime in proportions of 1 to 8, gave the key to the situation. Liquid spraying can also be done. The general principles are similar to those for control of potato beetles or cabbage worms on large acreages. The susceptibility of different varieties, the action of natural parasites, etc., were studied carefully. The data are sufficient to make an important publication, containing much strictly original matter.

ARMY WORMS

Just before the worm on soybeans began its ravages, the Fall Armyworm came into prominence in several localities, and during the soybean epidemic the True Army Worm broke out in grass and corn fields, often adjacent to bean fields, and close to our field stations. Studies were therefore made, incidentally, of the True Army Worm, and data was secured in regard to its parasites, which, when coördinated with similar data obtained in 1908 and 1914, gives a very good body of facts. Any adequate study of this pest must include the study of its parasites, as these are nature's own remedy, and an effective one, never, in our experience thus far, permitting two successive destructive generations of the True Army Worm.

INVASION OF STATE BY COTTON BOLL WEEVIL

It is proper here to record the fact that the cotton boll-weevil invaded North Carolina by its natural powers of spread in the autumn of this year (1919). It has been located at several places in the four extreme southeastern counties of Brunswick, Columbus, Robeson, and New Hanover. This will necessitate an extra amount of scouting and extension work, for which a special worker would be desirable.

ACKNOWLEDGEMENT

Finally, I have, as in previous reports, to gratefully acknowledge the faithful, loyal, and efficient services of each and every worker of our Division, as well as the kind support always accorded by yourself.

Respectfully submitted,

FRANKLIN SHERMAN,
Chief, Division of Entomology.

REPORT OF ENTOMOLOGIST

To the Director:

I beg to submit, herewith, a brief report on Entomology for the past year.

The main project carried on during the past year has been a study of the Leafhoppers of the State. In this work we have had the able assistance of Dr. Herbert Osborn of the Ohio State University, the recognized American authority of this group of insects. Dr. Osborn and I spent most of July, August, and September studying these insects in the fields at two field stations: Wilmington and Swannanoa. A great mass of data was collected during this time, which is being worked up as rapidly as time will permit. In addition to the usual field studies carried on, a great deal of work has been done on these insects. In addition to the usual life history and field studies, we have been indexing and cataloging the literature on this group of insects. This work has progressed very satisfactorily during the year, and is about half completed. The Entomologist has devoted considerable time to the identification of leafhoppers for other entomologists in various parts of the world. Large collections have been studied from South Dakota, from Nebraska, from the Phillippines, from Columbia, South America, and from the French Guiana.

The work on the gloomy scale has been completed, except for a few minor points, and the data accumulated in these experiments is about ready for publication.

Experiments on the life history and control of the tobacco flea beetle have been carried on in the eastern tobacco section, and a bulletin giving the results of this work has been issued as Bulletin No. 239, "The Tobacco Flea Beetle." It is our purpose to continue these experiments in the old tobacco belt, in order to determine in what way it will be necessary for us to modify our recommendations for dealing with this pest in the regions where tobacco has been grown for a number of years.

The corn root worm experiments have been continued at Willard, Wenona, Kingsboro, and Raleigh. The experiments are carried on in coöperation with the Division of Cereal Insects, United States Bureau of Entomology, and it is our expectation to continue them for several years.

The life history studies of the pea and bean weevils are being continued, but no new facts of special importance have been developed.

Respectfully submitted,

Z. P. Metcalf,
Entomologist.

REPORT OF THE DIVISION OF HORTICULTURE

To the Director:

I herewith submit the report of the experimental work of the Division of Horticulture for the fiscal year ending June 30, 1919.

The experimental work of the Division is being continued along the lines of the projects described in previous reports. Some phases of the work conducted have been in progress for a sufficient number of years to furnish data, which are being arranged for publications.

Several additional projects have been added during the year.

The experimental work of the Division was greatly handicapped in the early part of the year, due to the limited number of workers available. Throughout the war period it was not possible to secure competent men to fill the vacancies that existed.

During the latter part of the year, however, the vacancies were filled, and the Division is now in a position to adequately conduct the investigations in progress.

Mr. L. H. Nelson was appointed Assistant Horticulturist in April for work in vegetable culture. Mr. J. M. Dyer was appointed Assistant Horticulturist in September for work in Pomology.

EXPERIMENTAL WORK IN POMOLOGY

1. *Variety Work in Pomology.* (C. D. Matthews and J. M. Dyer.) Notes and observations, on the behavior of varieties of fruits in the different sections of the State, are made from year to year. These notes and observations show the range of adaptability of the varieties in different sections.

Much time and care is expended each year in writing, revising, and checking descriptions of almost all of the important varieties of fruit grown in the State. These descriptions are to be used in future publications, and are employed by the Division as an aid in identifying varieties of fruit sent to the office from over the State.

2. *Native Fruits of North Carolina.* (C. D. Matthews.) The place of origin, the history, and the description of a number of varieties of North Carolina origin have been secured. When opportunity offered, the descriptions of varieties secured previous to this season were verified. Paintings and photographs have been made of the most important varieties.

3. *Investigational Work with Peaches* (Mountain Station, Truck Station, Piedmont Station, Coastal Plain Station). (C. D. Matthews and J. M. Dyer.)

(*a*) *"Dehorning" Peach Trees.* During this last season additional progress with the peach "dehorning" project has been made. From the results so far secured, it has been shown that in years, when the buds are killed by cold, "dehorning" is a profitable practice in renewing old trees. It has been found that the operation may be done relatively late in the spring with satisfactory results.

(*b*) *Peach Breeding.* It is the object of this project to produce improved commercial varieties that are more suited to North Carolina conditions, than are the present varieties. It is the purpose, also, to produce varieties hardier in bud than the present commercial kinds.

To provide working material for this project, a variety orchard containing over 60 different varieties of peaches was planted at the Truck Station during 1917. These trees have grown so satisfactorily that active work can be done during the following year on this project, favorable weather conditions permitting.

(*c*) *Hardiness of Peach Varieties in Western North Carolina.* Twenty varieties of peaches, comprising varieties adapted both to extreme northern and to southern conditions, were planted at the Mountain Station in the spring to furnish material for work on determining the relative hardiness of different peach varieties in western North Carolina. These trees made a satisfactory growth during the year.

4. *Investigational Work with Pecans* (Truck Station, Coastal Plain Station, and Piedmont Station). (C. D. Matthews and J. M. Dyer.)

(*a*) *Variety Testing.* Twenty-two of the most important southern varieties are included in this test, which has been conducted for nearly 13 years. Gratifying results are being secured from this work, as certain varieties are showing marked adaptability to North Carolina conditions, while others are proving to be undesirable. At this time valuable recommendations regarding pecan varieties for planting in this State can be made. The trees produced the largest crop this year in the history of the orchards. Many trees produced over 50 pounds of nuts.

(*b*) *Securing Individual Tree Performance Records.* The securing of performance records of the individual pecan trees in the experimental orchards at the several stations is being continued from year to year. Such a record affords a more detailed study of the behavior of the different varieties. As a result of the individual tree performance records, it has been noted, that trees of the same variety under identical conditions are uniformly heavy yielders, while others are very poor producers; that some produce uniformly large nuts and others uniformly small nuts. As these individual performance records suggest the possibility of improving and standardizing individual yields by bud selection, work has been started along this line.

(*c*) *Cultural Practices.* The value of correct cultural practices, such as tillage and the use of cover crops, is clearly shown in the increased size of trees and in the increased size and number of nuts produced when compared to trees and their products grown in sod. To determine the most desirable system of tillage and cover cropping to be employed in pecan orchards, work of this nature is being conducted at the branch stations.

(*d*) *Pecan Breeding.* The seedlings secured as a result of pecan breeding work, set in 1915 at the Truck Station, are making a satisfactory growth. Some of these seedlings are of bearing size and should produce some nuts during the coming year.

(*e*) *Top-working Pecan Trees.* The investigations, dealing with the methods of budding and grafting, employed in top-working pecan trees were continued this year. It has been found that a combination of both grafting and budding should be used to secure the most satisfactory results. As a result of years of investigation, it is the opinion of this Division that top-working should be confined, as a general rule, to the trees not over 8 to 10 years old, to be entirely successful.

5. *Investigational Work with Strawberries* (Truck Station). (C. D. Matthews and L. H. Nelson.)

(*a*) *Variety Testing.* The variety-testing project with strawberries was initiated with the purpose of determining whether or not there are any other varieties more desirable as commercial market varieties than Klondike and Missionary, the two leading commercial varieties. For this State the most profitable berry combines the characteristics of productiveness, earliness, and shipping quality. Twenty-three varieties have been tested in comparison with Klondike and Missionary as regards these characteristics. To determine the shipping value of each variety, shipping tests have been made. None of the varieties tested have shown themselves superior to Klondike and Missionary as commercial varieties. Several of the varieties have shown themselves valuable for home use.

(*b*) *Cultural Practices.* During the year experiments to determine the most desirable planting date were started. Work to determine the value of removing blossoms and cutting runners was initiated. This project has not been in operation a sufficient length of time to furnish any conclusive information.

6. *Investigations with Apples* (Mountain Station). (C. D. Matthews and J. M. Dyer.)

(*a*) *Pruning.* The pruning project was begun during the year with the intention of securing information on the desirable height to head apple trees, to determine the comparative value of the open head and the modified leader system of training, and to secure information on the amount of annual pruning most desirable. To supply material for this work an orchard containing approximately 128 trees was planted at the Mountain Station during the spring.

EXPERIMENTAL WORK IN VEGETABLE CULTURE

1. *Investigational Work with Sweet Potatoes* (Truck Station). (C. D. Matthews and L. H. Nelson.)

(*a*) *Variety Testing.* It is the purpose of this work to determine the most desirable varieties of sweet potatoes for eastern North Carolina from the standpoint of productivity, market value, keeping quality, and quality. There were 19 varieties under observation this year. The results were, in the main, confirmatory of the work of previous seasons. Certain varieties have proven their desirability, while others have shown themselves to be undesirable.

(*b*) *Storage.* In connection with the variety work, storage tests are being made from year to year in the storage house to determine the behavior of the different varieties in storage. Certain varieties have proven themselves to be better keepers than others.

Investigations to determine the relation of proper harvesting to keeping quality, the proper method of curing, and the correct management of the house, have been continued this season. As a result of this work, the Division of Horticulture can authoritatively make recommendations regarding varieties for storage and the most desirable methods to employ in the management of the storage house. The work further shows the advisability of employing houses of this type for storage, as the average loss from all varieties has been less than 6 per cent in 1919.

(*c*) *Cultural Practices.* During the year work was done to secure information on the comparative value of the following different cultural practices:

The comparative value of slips vs. vine cuttings as regards productivity.

The effect of ridging on productivity and type of potatoes.

The effect of vine cutting on yield.

(*d*) *Seed Selection.* The following lines of work dealing with the seed selection of sweet potatoes were initiated this year:

To determine the relative value of seed stock from high yielding and low yielding hills (disease-free stock only to be used) as regards:

Productivity

Uniformity of potatoes

To determine the relative value of vine cuttings as compared with the slips for maintaining yield and type, commencing from same hill.

To determine the comparative value of large and small potatoes for seed. Very satisfactory progress was made with this work during the year.

2. *Investigational Work with Irish Potatoes* (Mountain Station and Truck Station). (C. D. Matthews, L. H. Nelson, and S. C. Clapp.)

(*a*) *Variety Testing.* The testing of varieties of Irish potatoes, to determine the most desirable varieties for western North Carolina conditions, was continued this year with 20 varieties. The testing has been

in progress for a sufficient length of time to supply this Division with the necessary information to make reliable recommendations regarding the choice of varieties for the western part of the State.

(*b*) *Hill and Tuber Unit Selection Work*: The hill and tuber unit selection method of variety improvement is being employed in an attempt to produce strains of the best varieties with greater productivity and more desirable characters.

3. *Investigational Work with Cabbage* (Mountain Station). (C. D. Matthews, L. H. Nelson, and S. C. Clapp.)

(*a*) *Variety Testing.* The testing of varieties of cabbage, to determine the most desirable varieties for western North Carolina, was continued this year. The testing has been in progress for a sufficient length of time to supply this Division with the necessary information to make reliable recommendations regarding the choice of varieties for the western part of the State.

(*b*) *Date of Planting.* Work to determine the most satisfactory date for transplanting cabbage was continued during the year.

4. *Observation Garden* (Truck Station). (C. D. Matthews and L. H. Nelson.) The all year observation garden at the Truck Station has proven very valuable in supplying information regarding varieties and planting dates of different vegetables for eastern North Carolina. It has been of value also as a demonstration in gardening, and has been an inspiration to many visitors who have seen it.

Respectfully submitted,

C. D. Matthews,

Acting Chief, Division of Horticulture.

REPORT OF HORTICULTURIST

To the Director:

I have the honor to submit the following report for the year ending June 30, 1919:

The work of research, in connection with muscadine grapes, has progressed during the year without interruption, especial attention having been directed toward the completion of some of the earlier projects as outlined, and the collection of material and prosecution of those of later development. A summary of the six lines of investigation, as they exist at the end of the year, follows:

Project No. 4, "Further Studies of the Inheritance of Sex," is practically complete as outlined, there being but a small amount of data to be secured during the present summer and fall. Report on this work has been made and published at various times, chiefly in Technical Bulletin No. 12, "Inheritance of Sex in Vitis Rotundifolia."

Project No. 5, "Productivity of Rotundifolia Grapes," is practically completed as far as it can be, without the making of systematic vine and variety tests. This work is not recognized as pure research, and, therefore, cannot be carried out at this point. It would, therefore, seem desirable that some of the superior vines grown be tried out on a larger scale than is possible here, and those which possess sufficient merit be introduced to the trade. There are about ten or twelve vines of merit sufficiently great to warrant such observation.

Project No. 6, "Inheritance of Color in Rotundifolia Grapes" is complete as outlined. Report of this work has been made in Technical Bulletin No. 10.

Project No. 7, "Further Studies of the Inheritance of Size of Fruits" is being continued. Partial reports have been made from time to time as warranted.

Project No. 8, "A Study of Quality Characters in Rotundifolia Grapes" is a line of study on which, up to the present time, little work has been done. Some observations as to flavor have been made and reported upon, but others, including disease resistance, are as yet to be worked out.

Project No. 9, "Hybridization of Vitis Rotundifolia with Other Species," is an investigation looking toward the establishment of the limits of hybridization of this species, and the formation of a scale of crossing profitable for use in connection with it. This subject has been the one of especial interest during the year, and although it has been difficult to secure stock of all the species needed, some results have been obtained with the material already on hand. These results have been submitted for publication during the year, and will appear shortly. One of these (Technical Bulletin No. 17) is by way of summary of the work of other investigators, and a report of the results accomplished at this station up to the present time. The other (Technical Bulletin No. 18), deals with the subject of hybrids, both true and false, of which numbers of the latter have found their way into cultivation. The proof of the spurious character of these so-called hybrid varieties serves to clear the way for future work along this line.

New projects have not been instituted as yet, because suitable conditions and necessary time have not been available. It is expected that with a return to more normal conditions, some of these investigations can be carried on.

Respectfully submitted,

J. P. PILLSBURY,
Horticulturist.

REPORT OF THE DIVISION OF PLANT PATHOLOGY AND BACTERIOLOGY

To the Director:

Pursuant of your request, I am herewith submitting a brief report concerning the work of this Division for the fiscal year ending June 30, 1919.

The investigations have been continued, interruptedly, along the several lines mentioned in the previous report, namely, on certain diseases of tobacco and of soybeans. The changes in staff involved by my return on March 1, 1919, and the resignation of Dr. W. H. Tisdale, who was in charge during my absence, together with the lack of assistants, have made impossible the usual progress in the work of investigation. Data of value have been secured, however, and will be incorporated in published accounts of the several diseases. The laboratory studies on the projects have reached the point where access must be had to field tests if adequate proof on methods of control of these diseases is to be secured. It is suggested that this need be met by some project method of support on the Branch Experiment Stations.

Considerable time has furthermore been devoted to a little known vetch disease, which was so generally destructive throughout the State during the spring of 1919, as to practically prevent the formation of seed. The investigations on this disease should be completed during the coming year and prepared for publication.

The only publication of note from this Division during the year has been Technical Bulletin 16 on "Clover Stem Rot." The disease not only attacks crimson clover, but also red clover, white clover, alsike clover, and alfalfa. It may be recognized by a sudden wilting and death of plants in spots, a decay of stems near the surface of the ground, and the presence of black sclerotia in these decaying stems. The causal organism is different from the one causing lettuce drop, with which it has been regarded by some as probably identical. The lettuce drop organism will, however, attack crimson clover, and the stem rot organism will infect lettuce. The disease may be avoided by the use of seed free from sclerotia, by the exercise of care when soil is used to inoculate new fields with nodule forming bacteria, and by not returning manure to clover fields when hay from infested fields is fed. In badly infected fields, cowpeas and soybeans must replace crimson clover as a legume in the rotation system, and winter grains must serve as cover crops.

Respectfully submitted,

Frederick A. Wolf,

Chief, Division of Plant Pathology.

REPORT OF DIVISION OF MARKETS AND RURAL ORGANIZATION IN NORTH CAROLINA

To the Director:

This report is for the year ending December 1, 1919, and covers the investigations, extension, and service work of the Division of Markets and Rural Organization, conducted jointly or separately by the North Carolina Department of Agriculture and the North Carolina State College of Agriculture and Engineering, in coöperation with the United States Department of Agriculture under the agreements and plans entered into by these institutions for the conduct of all agricultural work of this kind in the State.

WAREHOUSE SURVEYS

In 1913 the North Carolina Division of Markets, in coöperation with the Federal Bureau of Markets, made the first survey of cotton warehouse and credit facilities in North Carolina. The counties producing 3,000 or more bales of cotton per year had a storage capacity of 88,875 bales, exclusive of private and mill warehouses. In fact, the first survey of warehouse facilities in the United States was begun in North Carolina. In 1914, when the price of cotton dropped to six cents a pound, another survey made by the Division of Markets showed that an additional warehouse capacity had been developed to meet the emergency of the war amounting to 181,015 bales capacity above what was available to farmers before the war. Of this amount room for 46,100 bales was provided by the cotton mills. This was a time when the farmer had to hold his cotton, or make a great sacrifice. What is more, the merchants and other business interests in the cotton belt could not afford to allow such a sacrifice.

The survey of North Carolina warehouses, made this year, is not complete enough to show the precise capacity of storage houses now available for farmers; but it does indicate, as in 1913, that most of the cotton warehouse space is controlled and used by buyers. Even warehouse companies, which operate public warehouses generally, prefer to store the cotton of buyers, rather than that of the ordinary farmer, as the expense of storage of small amounts is too high to be profitable. The greater rate of cost for storage of farmers' cotton, when it is sold in small lots, should be considered. This extra cost, however, may be met if the Farmers' Warehouse Companies will employ a manager that is capable of acting also as a sales agent for the depositors of cotton. Then the cotton can be sold out in large, even running lots. Our cotton survey has shown that the larger farmer usually obtains a higher price for cotton.

If the farmers were organized to market their cotton in large, even running lots through their own warehouse companies, they would not be selling cotton now at one to four cents below the market, and would

not be losing, in most places, from five to twenty dollars per bale. The State Warehouse Superintendent, in carrying out the provisions of the State Warehouse Act, will be in an excellent position to assist any farmers or merchants who have cotton stored in State warehouses to market their cotton, as the law requires that the superintendent keep a record of the grade, staple, and weight of all cotton stored in the State system. To efficiently carry out the provisions of the law to assist depositors of cotton to market their cotton, it will be necessary for this Division to make its present weekly price report a daily report for cotton. This will be necessary for the information of the superintendent and of the depositors of cotton. The State Warehouse Act requires that all cotton stored in a State warehouse be graded. This can be done by our State graders or by graders licensed under the North Carolina standard grading law, or under the United States Warehouse Act. On the other hand, if the warehouse company acts as a marketing agency for its depositors it will make our grading service more effective, as it has been found that buyers generally will not buy cotton on the basis of State grades unless the seller is in a position to find other markets where the cotton may be sold on the basis of such grades. Thus, the State Warehouse System, to be effective, has to be combined with the organization work, cotton grading, market news service, and sales work of the State and Federal Bureaus of Markets. Such a complete system will have all the necessary elements of success in it for the operation of the State and Federal Warehouse System.

GRAIN AND SOYBEANS

Surveys have been made of roller mills to find out the demand for corn. Last year North Carolina mills were in the market for a considerable amount of North Carolina corn, but this year improvement of transportation, and decreased demand for corn as a substitute for flour, has made the mills less interested in home grown corn. Lists of interested mills and buyers have been furnished to growers and shippers of corn. The great difficulty of farmers shipping their own products has been lack of warehouse space. The Hyde County Grain Exchange, organized by this Division, may be said to have failed largely because of lack of a warehouse for assembling corn, soybeans, and oats. This county, alone, loses approximately $25,000 yearly for lack of proper marketing facilities.

Wholesale receivers do not care to buy direct from farmers who are not prepared to make immediate delivery in the quantity wanted. The proposed warehouses at Elizabeth City and New Bern, together with the one already existing at Washington, would enable many of the farmers of our corn belt to store corn for spring and summer sale when local corn has been sold, and when only prices are as high as, or higher, than the price of western corn delivered in this State. A warehouse

company, with an efficient sales manager, can guarantee quality of grain and develop a reputation for business methods.

A survey of the market for soybeans has also been made, through letters addressed to seed houses and to marketing agents in other States. Prices producers secured for soybeans have been found to be $1.50 to $2 per bushel as compared with $3 to $4 last year. After the farmers had sold practically all of their soybeans, the price rose to $3 per bushel, or better. The opinion is held that if growers had been organized to store their soybeans and to market them when the trade had sold out its holdings of last year's stock, growers would have been able to receive three dollars a bushel for their crop. One or more county agents have had trouble with receiving seed that would not germinate. The remedy seems to be for farmers to organize warehouse companies in accordance with the warehouse and coöperative laws of North Carolina, put their soybeans in storage, clean, and grade them under the provisions of the North Carolina Standard Grading Law, borrow money, if need be, on their warehouse receipts, and be ready to sell in large, even running car lots direct to wholesale seed houses, or to farmers' clubs through State marketing officials and county agents, when prices are satisfactory.

PEANUTS

A survey in person was made of the market for peanuts in Suffolk, Norfolk, New York, and Philadelphia, and by letter or wire of Pacific Coast and Southern markets. Very soon after the Armistice was signed, Virginia peanuts dropped in price to the producers from nine cents a pound to four and five, a decline that has no parallel in any other food product. Farmers were unable to sell more than a few peanuts at any price. The trade had a considerable hold over from last year, and after the demoralization in prices, was only willing to buy from "hand to mouth." The cleaners appeared to fear that the removal of the embargo upon foreign peanuts by the War Industries Board would cause all American markets to be flooded with low price nuts. As prices quickly recovered, the removal of the embargo proved to have only a temporary effect. Cleaners claimed that maintenance of war prices to producers would not permit of consumption of the larger crop assumed, but admitted street venders were selling peanuts to consumers at war prices, and making from $15 to $25 per bag profit. Farmers are estimated to have sold peanuts with little profit, and in most cases with some loss, the loss ranging, in some cases, as high as $25 per acre. One of the leading manufacturers of peanut butter, candy, and salted peanuts was of the opinion that conditions would have been greatly improved if cleaners had carried on an advertising campaign to dispose of peanuts through the retail grocer as soon as the War Industry Board declared peanut marketing by street venders as a nonessential industry. In May and June, after farmers disposed of the most of their crop, prices recovered

a large part of the slump, rising to seven and eight and one-half cents a pound for Virginia nuts. Circulars, based upon these investigations which we issued, helped to give farmers confidence at a time of general business demoralization. Most farmers have no suitable storage facilities for holding peanuts. Besides, a large part of the crop is owned by tenants or small farmers who are obliged to sell at some price. For any plan of organization to be effective, the membership would need to control a large part of the crop. Provisions would have to be made for financing the holding of the "distressed" peanuts, proper storage facilities built, and arrangements made for the Growers' Exchange to enter into a collective bargain with the cleaners. A collective bargain, as worked out by the California Prune and Strawberry Growers, and by milk producers in other States, must include in the contract detailed provisions as to grades, rate of sale, and price. The program of the Virginia-Carolina Peanut Exchange does not seem to meet these minimum requirements. The warehouse companies being organized in the peanut belt are making plans to solve these problems.

SWEET POTATOES

A survey was made of sweet potato storage houses, variety, place of disposal, and prices received. This information showed that the demand during past year for sweet potatoes in storage houses was generally sufficient in local markets. In a few places, southern late sweet potatoes are shipped North, but the most of the crop is sold, either on local markets, or nearby markets in the State. In any event, prices have generally been so good this year, ranging from $1.50 to $2 per bushel, that little selling assistance has been necessary.

MOUNTAIN PRODUCTS

In the western counties of the State investigations have been carried on in varieties, culture, harvesting, grading, packing, and storing and marketing fruits and vegetables; especially apples and Irish potatoes. These investigations have shown the need of a few standard varieties adapted to this section, properly grown, harvested, graded, packed, stored, and marketed. One thing needing special emphasis in culture of both apples and potatoes is spraying. This need has been realized in the case of apples, and is coming to be realized in the case of potatoes. Marketing investigations have revealed in the case of potatoes, with an occasional rare exception, that late summer and early fall are the best times for farmers in western North Carolina to sell their Irish potatoes. The western North Carolina potatoes can be dug and put on the southern markets before the big eastern, northern, and western crops can reach these markets, at a time when the eastern shore and southern Irish potatoes have been cleaned up and the demand for potatoes is good. Only in years when the potato crop over the whole country is below

normal has it paid western North Carolina farmers to hold their Irish potatoes until winter or spring.

HOGS

A careful survey of the fat hog marketing situation showed that the prices obtained on local markets last fall and winter were, in most cases, relatively higher than packer markets. This was especially true with soft hogs, as local markets almost invariably paid as much for soft hogs as for hard hogs, while packer markets deducted from 2 to 4½ cents per pound for soft hogs. However, about February local prices began to drop, and by March were considerably lower than packer markets. This condition was favorable for encouraging and making coöperative car lot shipments to packer markets. Eighteen such shipments were made. In the past North Carolina hogs have been sold locally, a greater part of them going on the market as dressed hogs and as cured meat. However, with the adoption of the coöperative plan of selling, it is thought that selling on foot will rapidly grow in favor. The coöperative marketing of hogs is being urged where local markets are out of line with packer markets. The determination of whether hogs are hard or soft by packers has caused dissatisfaction and discouragement among farmers who have taken pains to harden their stock. It now seems evident that it will be necessary to have a disinterested party stationed at packing centers to determine whether hogs are killed hard or soft. It is thought that if such an arrangement can be made, many more North Carolina farmers will harden their hogs before marketing them.

BEEF CATTLE

The method of marketing feeder, stocker and butcher cattle in the western part of the State is being given considerable study. A large per cent of these cattle are sold by growers to dealers, who contract for them anywhere from one to six months prior to date of delivery. The prices obtained by growers are usually considerably below the actual value of the cattle. Growers are being encouraged to ship their butcher cattle to packer markets, rather than sell to local dealers, and some growers have shipped cattle this year, for the first time, with satisfactory results. During the past fall considerable assistance has been given in selling feeder cattle by bringing grower and feeder together, and several sales have been made in this way. However, this plan is only fairly satisfactory. Plans are now under way for holding two big feeder, stocker, and butcher cattle sales at two different points in the western part of the State during the fall of 1920. It is thought that this plan of selling these mountain cattle will be more satisfactory to the grower than the old plan, and at the same time encourage the raising of more cattle. Coöperative shipping of grass fat butcher cattle to packer markets is being encouraged, and a few such shipments have been made this year.

As a rule, heavy cattle command the best price on packer markets. Cattle feeders frequently object to North Carolina feeder cattle, on the grounds that they are not large enough when put in the feed lot to command the highest prices when finished. This fault could be overcome if the cattle raisers would keep their cattle a year longer before selling to cattle feeders.

The plan of marketing fat cattle in the central and eastern part of the State has also been investigated. A large per cent are sold to dealers who travel over the State. The feeders seem to prefer this plan of marketing, rather than shipping them to packer markets to be sold through commission men. When cattle feeders have a carload of cattle, and are posted as to the cattle market, they usually obtain a fair price for their cattle from these dealers. However, when a cattle feeder has only a few cattle for sale, or is not posted as to markets, it is quite likely that he will sell his cattle considerably under actual value. This office is encouraging cattle feeders to ship their fat cattle to packing centers, rather than sell them to traveling dealers.

It has been found that a large per cent of the cattle fattened in the State are sold before sufficiently fat to command the highest price at market. This is due largely to the fact that insufficient concentrates are fed, rather than to the length of the feeding period.

SHEEP AND WOOL

While there are relatively large numbers of sheep in the eastern counties of the State, very little attention has been given to marketing them. They are raised in small farm flocks, and farmers have been taking whatever they could get for them. Prices have not been such as to encourage improved breeding; consequently, the quality is somewhat inferior. Practically all sheep have been sold to local markets and consumed within the State. The coöperative shipments to northern markets, during the past few months, have caused the farmers to understand they can get full market value for their lambs and sheep, and new interest is being aroused in the industry. One great need, if they are to secure the best prices on northern markets, is improved breeding and care.

Western and Central North Carolina farmers grow sheep in larger flocks, give more attention to breed and care of flocks, have better marketing facilities, and obtain better prices. In this section many good local markets are available, and in some cases dealers buy and ship to northern markets. While this situation is far from ideal, it is much better than in eastern North Carolina, where buyers make purchases in small lots and operate on a larger margin of profit. The shipping of lambs to northern markets, from the extreme western counties of the State, is not so satisfactory as from the eastern counties, on account of distance and poor shipping facilities which cause more or less loss

en route. However, after arrival at market they command a higher price than eastern North Carolina lambs, due largely to improved breeding.

During the summer of 1919, six coöperative car lot shipments of lambs were sent to northern markets with very satisfactory results. In one case, the net price received was double the price offered locally. This plan of marketing will be pushed during the coming year.

The quality of wool produced in central and western North Carolina is good. A large per cent of it is sold to traveling buyers, who usually pay only one price for wool of a particular section, regardless of quality. The payment, by buyers, of a flat price for wool, as for cotton and other farm products, does not encourage the production of the best quality. The price obtained for this wool has always been low enough to allow the buyer a big profit. In the eastern counties a poorer grade of wool is produced. The plan of marketing this wool is the same as in the western part of the State, but it usually sells for considerably less. Taking the State as a whole, there is a decided need for a better plan of marketing both wool and lambs. On the other hand, there is need for improved blood in the flocks, and better care and feed is needed in many cases.

During the past summer several coöperative sales of wool were made. In some cases the wool in a county was collected and held in storage until a satisfactory bid was made. In other cases small coöperative shipments were made direct to woollen mills. On August 20th wool from eight counties in the State was collected and shipped under the supervision of county agents to the Philadelphia market, where it was assembled, graded, and stored, and later sold. This plan of selling wool is only fairly satisfactory. It is thought a better plan would be to assemble and store it in three or four convenient places in the State, and later offer it at auction. Plans are now under way for holding at least two such sales next year.

THE ORGANIZATION OF THE STATE WAREHOUSE SYSTEM

Since early in September, when the present State Warehouse Superintendent was appointed, the warehouse regulations have been revised and printed; a form of North Carolina and United States negotiable warehouse receipt, together with coupons, has been drafted and printed; forms for nonnegotiable memorandum receipts and warehouse licenses have been drafted and printed; and a form of bond for bonding local warehousemen has been drafted and approved by the Assistant Attorney-General. The nonnegotiable warehouse receipt is to be given by the local manager of a warehouse to the depositor of cotton, and later is to be exchanged for a negotiable warehouse receipt when the cotton stored has been insured, weighed, and graded. The main changes in the revised regulations, as approved by the Warehouse Committee of the State

Board of Agriculture, are (1) to make the local manager responsible for the enforcement of the regulations under the United States Warehouse Act, as well as of those under the North Carolina Warehouse Act, and (2) to reduce the privilege fees charged warehousemen from five cents to one, three or five cents per bale per month. The amount of charge varies according to the saving on insurance to the warehouse. The previous flat charge of five cents per bale per month was prohibitive. The bond of $100,000 required under the State Warehouse Act has been arranged for the State Warehouse Superintendent with much difficulty, due to the present wording of the Warehouse Act.

According to section 17 of the Warehouse Act, the State Warehouse Superintendent is required to insure and keep insured all cotton stored in State warehouses. The present State Warehouse Superintendent has invited all general agents, brokers, and representatives of the local insurance agents to submit proposals which would meet the requirements of the law. To date only one agency has offered any such plan. The plan offered by this agency has been accepted, subject to the final approval of the State Board of Agriculture, and also subject to the condition that it remains the best plan offered. By this plan all warehouses brought under the State warehouse system, which have as good a system of inspection as that of the Federal, will obtain a twenty-five per cent reduction on existing insurance rates, provided they are nonsprinkler warehouses, and ten per cent reduction if they have a sprinkler system. It is further agreed that a floater policy of $300,000 will be issued to cover each warehouse, which will protect the State from any loss on account of any carelessness, up to the amount of $300,000. The records of this office are accepted as legal evidence of the cotton insured up to this amount. Any amount, either in excess of or under $300,000, may be taken out as a specific insurance with any company acceptable to the warehouse owners and to the State Warehouse Superintendent and Insurance Commissioner. If any other agency should offer a better plan, the floater policy should be required, and the other essential principles of this arrangement should be held to as fundamental for the protection of the State against loss. With the arrangement of this tentative agreement by the present State Warehouse Superintendent, the State warehouse system was made ready to operate on October 29th.

The warehouses of the State have been canvassed by letter once before the first of September, and twice since, to invite them to come into the State and Federal Warehouse System. Since the first of September, copies of Warehouse Bulletin, revised regulations, license blank, and of warehouse receipt have been mailed to each of the three hundred and thirty-six names we have on our warehouse mailing list. In addition, the beginning has been made by a personal canvass of all the principal warehouses in the State, which should be continued until completed, in order to give an opportunity for each warehouseman to ask questions and to

have them answered. This canvass will also serve to obtain a complete list of warehouses now active or available. Two applications for license have been received and one approved.

The mill warehouses, now, do not need the credit of the State to increase the value of their warehouse receipt as collateral for borrowing purposes. When the ever-recurring periods of money stringency come again, many of the mill owners may be glad of the support of the credit of the State to increase the borrowing power of their warehouse receipts. The same will be true of the buyers' warehouses, which constitute almost all the other warehouses of the State. Most of the farmers' warehouses, which once were scattered over the State, have passed into other hands.

No special appropriation was allowed for this warehouse work by the board, and, therefore, it has not been possible to employ additional assistants. The warehouse work will need to be made as strictly an educational project as any other line of work conducted by the agricultural institutions of the State. There is no more reason why the warehouse project should be made to pay its own way than any other line of production or marketing work. Warehousemen are not going to come under the State and Federal system until they understand fully the requirements of the warehouse acts and regulations, and the advantages of operating a warehouse under this system.

PROMOTION AND ASSISTANCE IN THE MAINTENANCE OF WAREHOUSE AND MARKETING ORGANIZATIONS

Organization of Warehouse Companies to Operate Under State and Federal Warehouse System

The low price of cotton last spring and summer, and the losses suffered from holding cotton out-of-doors, has made this a favorable year for the organization of warehouse companies for operation in the State and Federal Warehouse System. Farmers, generally, have shown an interest in organizing warehouse companies under the coöperative and warehouse acts of North Carolina. Then the field is comparatively clear for starting such projects, as most all of the farmers' warehouses have gone out of existence, and most of those warehouses in existence are under the control of cotton buyers or mill owners. However, the tenth of September, when the present State Warehouse Superintendent was appointed, was a rather late date for promoting warehouse companies this year.

A plan of organization of a warehouse company was worked out in connection with the Chowan Coöperative Warehouse Company, which the present Acting State Superintendent of Warehouses promoted, in coöperation with the county agents of Hertford and Bertie counties. By-laws and a form of stock subscription blank were furnished this organization. The company plans to operate a chain of warehouses

under one manager, and to store and market cotton and peanuts. The farmers in these two counties have not pushed the sale of sufficient stock to build the three warehouses planned, as it has been decided that the present high prices do not warrant the holding of cotton.

Though this may not be a good time for holding cotton, it is highly important that farmers, bankers, and merchants use the present time of prosperity and surplus funds to organize a warehouse company, and to subscribe sufficient capital which can be utilized for building warehouses another summer when material may be bought at lower prices. If, however, the capital is not collected now, the present surplus of money may be spent and, therefore, would not be available for warehouse construction in time for meeting the great need for warehouses in the future.

A plan for a chain of warehouses has been adopted and carried out by the Northampton Warehouse Company, which has thirty-four thousand dollars subscribed toward building three warehouses at Seaboard, Jackson, and Rich Square. Two of these warehouses will be built at once. This company also plans to market, as well as store, both cotton and peanuts, and to secure a competent manager for this purpose. Competent managers will need to possess ability to act as sales agents, as well as warehouse managers. Farmers seem to be willing to pay a guaranteed minimum salary of $1,500 to $2,400, with a percentage of net profits to be given as a bonus, which together should make a salary of $2,500 to $4,000 per year. At least one other such warehouse company should be organized in the peanut belt, in order to construct and operate warehouses in Washington and Martin counties. A banker and the county agent at Plymouth are ready to proceed as soon as the services of an organizer can be secured. A company, with a paid in capital stock of $5,000, has been formed to build a warehouse at Conetoe. However, this warehouse company had best be made a part of the company which will be organized at Plymouth.

Larger concentration warehouses should be built at New Bern and Elizabeth City to store cotton, corn, soybeans, and any other products which are brought from nearby or distant sections for disposal on these markets. Washington, with similar conditions, has a storage warehouse with a capacity of 6,000 bales, which shows what a warehouse can accomplish. It is one of the very few purely public warehouses in the State. This warehouse stores cotton, corn, soybeans, and other products of commerce. It has a very low insurance rate of 20 cents per hundred. Automobile dealers find it profitable to store machines in this warehouse, because of the saving in insurance. Some plan should be worked out to enlist the farmers of Hyde County to take an interest in this warehouse, as undoubtedly they will if this warehouse company obtains an efficient sales manager, and if a canvass is made to show them the advantages of assembling their products in a warehouse. However, all warehouses,

especially those located in the territory tributary to Norfolk, to serve their depositors must have efficient sales managers. To find efficient sales and warehouse managers, with ability to keep track of markets for such diverse products as cotton, peanuts, soybeans and corn, will be one of the most difficult tasks. Upon the solution of this problem will depend the development of an efficient marketing system for handling the farm products of the whole northeastern North Carolina.

The companies which are being organized in northeastern North Carolina will look to the State Warehouse Superintendent to fully carry out the provision of the law which gives him the authority to market the cotton stored in all warehouses upon the application of the owners. Warehouse companies, to build warehouses and operate them under the State system, are also being formed at Greenville, Warsaw, Clinton, Fayetteville, Angier, and Monroe. Eight warehouse companies, being thus promoted, have a subscribed capital of approximately $160,000. There are good prospects for warehouses at Smithfield, Dunn, Lumberton, and Rowland. If possible, the warehouses to be built at Clinton, Warsaw, Burgaw, and possibly Faison, should be operated as a chain of warehouses by one company under one first-class manager, with assistant managers for each warehouse.

Such cities as Fayetteville, Raleigh, Goldsboro, Wilson, and possibly Wilmington, should become great concentration points according to a plan similar to that adopted at Spartanburg, South Carolina. At Spartanburg auto trucks bring in cotton from thirty miles around at a cheaper rate than freight. However, the auto truck in localities where production is more scattering, might not be feasible. If the railroads will extend the storage-in-transit privilege to all these cities, successful operation of large warehouses in them will be assured.

The North Carolina Warehouse Law is so drastic and complete in its provisions for safeguarding the warehouse receipt that bankers usually have shown a positive interest in our warehouse organization work, and should be expected to lend every effort to coöperate with farmers and business men to build warehouses. The State and Federal warehouse receipt will furnish the bankers the very best security with which to secure funds in time of money stringency.

If, however, farmers do not proceed at once, buyers will erect warehouses of their own and preëmpt the field. For the farmers to control their own warehouses, so that they can store when the need is greatest, the State Department will need to provide the necessary funds for the Division of Markets to have one organizer in the field full time for the next six months to a year. This will assure such understanding of the coöperative and warehouse acts in the promotion of the warehouse companies as to conserve the farmers' interest, and to assure that all companies promoted will come into the State and Federal system as soon as formed.

Any farmers' warehouse company, which is not formed under co-operative law, is likely sooner or later to pass out of their hands. This is another important reason why some one should be appointed as organizer, so as to instruct the farmers in the advantages of coöperative law. The coöperative law gives farmers authority to restrict membership to those agreed in their purpose, to limit voting power to one vote to each member, to limit dividends to six per cent, and to prorate surplus profits to depositors of cotton and other products in proportion to the amount stored. This prorating of surplus profits will give depositors a reduced storage rate at cost, and thus encourage a maximum use of the warehouses by farmers.

According to investigations made by the Bureau of Markets in this and other States, cotton on an average is damaged by weather exposure two dollars and a half per bale. If this amount were saved each year, it alone would build the warehouses for the State warehouse system. If each farmer in North Carolina would invest at the rate of three dollars per bale, this, with the help of business men, would build most of the warehouses needed in the cotton producing counties. Thus, the saving from weather damage would pay every farmer to own stock on the basis above specified as a part of the necessary equipment of his farm; in fact, quite as necessary to a cotton farmer as a barn for storage of farm machinery and feed.

It will be a great help to make the warehouse company pay expenses including dividend, and a fund to cover depreciation of building, if arrangements are made in each county to have the official weigher of the warehouses appointed by the county commissioners as an official weigher for the county.

As soon as a half dozen warehouses are in operation under the State warehouse system, weekly and monthly reports should be issued for warehouses similar to those now issued for the credit unions. These reports should be sent to all shareholders of warehouse companies, or to owners of warehouses, and to North Carolina mill owners and to any interested mill owner outside of the State. This will maintain the interest of the shareholders, and draw the attention of the mill owners to the kind of cotton available in North Carolina warehouses. Statements should indicate cotton received each week and delivered, and amount on hand of each grade and staple.

PROMOTION AND MAINTENANCE OF MARKETING ASSOCIATIONS

A new organization, known as the Eastern Carolina Produce Exchange, with central office at Aurora and branch offices at Washington and Pantego, has been promoted by this office for marketing Irish potatoes. The membership of this organization is already sixty-one, and the acreage, which was contracted to be handled through the exchange, amounted to six hundred and thirty. This exchange marketed

150 cars of potatoes during June, 1919, with an estimated saving to the growers of from $15,000 to $25,000. The average net price, received by growers from 21,889 barrels of grade one, was $4.70 per barrel, and for 3,778 barrels of grade two $2.50 per barrel, or an average net price of $4.45 per barrel for all grades. This exchange designed and adopted an excellent brand, and had the brand and grade printed on its cloth top barrel covers, which added greatly to the selling value of its potatoes. This division licensed the four inspectors of the Exchange, and furnished the service of a supervising inspector, so that the Exchange had authority to, and did issue certificates of grade according to the provisions of the Standard Package and Grading Law. With the Carolina Potato Exchange at Elizabeth City, and the new exchange, there will be organizations in all leading early Irish potato producing sections, except the Mt. Olive section, where several unsuccessful attempts have been made to organize.

The Carolina Potato Exchange, which was organized by this Division in the year 1914, marketed for its members this year 169 cars of Irish and sweet potatoes. The 42 cars of Irish potatoes netted the growers $4.46½ per barrel. The 7,258 barrels number ones netted $4.52 per barrel, and the 212 barrels of number twos brought the growers $2.36 per barrel. The 21,572 barrels of Big Stem Jersey Sweet Potatoes, grade one, brought the growers $4.77 per barrel, and the 577 barrels of grade two $2.56 per barrel.

An assistant manager was furnished to the Tabor Produce Exchange this year, who assisted the Exchange to market twenty-five cars of strawberries. One cold storage and marketing association for handling apples, potatoes, and cabbage in the mountains, two peanut and cotton warehouses, and one strawberry association in eastern North Carolina are being promoted. A representative of this Division acted as manager for the Mountain Growers' Exchange, and, from the branch office located at Waynesville, looked after the marketing of perishable products grown in the mountains. Six cars of late Irish potatoes, United States grade one, sold early in August, netted the members of the Exchange $1.83 3/5 per bushel. The potatoes sold in October brought the members $1.53 per bulk bushel.

Representatives of the Division of Markets, and of the Federal Bureau of Markets, coöperated with the members of the Edgecombe Cotton Exchange to secure a reorganization of the association. The Exchange entered into a contract with members, which was enforced by a note to cover damages for nonfulfillment, to market about 1,500 bales of cotton for the members. This cotton was stored in a warehouse to await the rise of prices.

Growers have been assisted in marketing 18 cars of hogs, and 6 cars of lambs coöperatively, and in selling approximately 12 cars of cattle. Plans are under way for organizing 4 coöperative livestock marketing associations. In most cases, they have resulted in a considerable saving

to shippers. One car lot shipment resulted in a saving of $591.39 over price offered locally.

ORGANIZATION, INCORPORATION, AND SUPERVISION OF CREDIT UNIONS

Twelve new credit unions have been organized, and three old credit unions given a new start. The resources of the North Carolina credit unions have increased from $25,325.98 in 1918, to $53,437.07 on September 30, 1919. Less money is borrowed from the banks, and more obtained from shareholders and depositors. The credit unions of this State have doubled in resources each year from the beginning of the work. If this rate of growth continues, their resources in five years will amount to $1,600,000. Wherever a community possesses leadership and experience in coöperation, credit unions are easy to organize and maintain. The difficulty is the general absence of disinterested leadership in the country community.

It has been proven in North Carolina, as in European countries, that credit unions are of assistance to the banks which are selected as depositories in bringing savings to them. The Bahama Credit Union increased its deposits about eight thousand dollars in four to six months. This credit union is in a county of the State in which the bankers had carried on a campaign to obtain deposits. It was found that 40 per cent of the depositors of the Bahama Credit Union had not been doing business with any bank before. The bank pays the credit union 4 per cent, and the latter agency pays members or nonmembers four per cent for deposits. The credit union pays its own expense out of the profit on the loans it makes to its members for which it charges six per cent.

The credit unions in this State grant their main loans to assist their members to make coöperative cash wholesale purchase of fertilizers. This is evident from the following very excellent report which was made by the treasurer of the Carmel Credit Union.

LOANS MADE BY THE CARMEL CREDIT UNION AND SAVINGS MADE BY MEMBERS THROUGH COOPERATIVE PURCHASE OF SUPPLIES FROM JANUARY 1, 1919, TO JUNE 1, 1919

Money Borrowed	*Amount Borrowed*	*Estimated Time Price and Interest*	*Amt. of Saving Through Cash Purchase*
For fertilizer	$2,360.00	$2,714.00	$354.00
For mules	150.00	165.00	15.00
For food and feedstuff	350.00	385.00	35.00
For labor	265.00	265.00	.....
For farm machinery	115.00	126.00	11.00
For cows	500.00	550.00	50.00
For milk trucks	500.00	600.00	100.00
For holding cotton	560.00	760.00	200.00
For digging well	100.00	110.00	10.00
For repairing barn	75.00	82.50	7.50
To secure farm loan	300.00	322.00	22.00
	$5,275.00	$6,080.00	$805.00

Time of loan: 60 days to 12 months.
Number borrowers, 22; saving to each borrower, average $36.59.
Number notes made, 32; average loan, $165.

Bought 60 bus. soja beans { $165. Individual purchase price cost.
117. Coöperative purchase price cost.
$ 48. Saving.

Enabled 20 bales cotton to be held for 2 cents lb. better price. Saving, $200.

The interest in our credit unions is widespread. We have coöperated with persons throughout the United States who are interested in promoting coöperative credit legislation, and organization of credit unions among farmers and wage earners.

The progress of our credit union must be slow until farmers realize the necessity to organize for coöperative credit, in order to be free to buy where they can buy cheapest, and free to sell where they can sell to advantage. Farmers who are dependent upon the supply store form of credit are not free to coöperate to market their products through organizations controlled by themselves. This has already been proven true of cotton, peanuts, and potatoes in this State. The credit unions, in providing credit for farmers at a more reasonable rate than supply merchants, are not making their profit from the sale of farm supplies, and, therefore, have no interest in restricting diversification in agriculture. A *progressive agriculture* cannot be expected among farmers unless they are in control of their own system of credit and are free to grow what they choose. Farmers have the alternative of wasting their surplus in expenditure for luxuries, or in building up a supply of credit under their own control, which they can use in hard times when the need for credit extension is general and when bankers never have sufficient money to meet the needs of the rural community at large, when, in fact, the bankers say they can only look after their regular customers. The war has given the farmers a surplus. If they do not use it to build up their own credit organizations, they may have to again bear the burden and expense of the old supply store system.

During the war, rising prices have greatly increased the profits of farming, as of other industries. But, as soon as falling prices set in, costs will be high, for the production of farm products, margin of profits will be small or disappear entirely, and advances, or some form of credit, will again be needed in greatly increased amounts in order to run the farm from one crop sale to the next. In the next few years, therefore, the organization of credit unions will be much more urgent and rapid in this State, for the ground has been broken and the favorable attitude of mind on the part of the farmers slowly created, so that they are beginning to realize as never before the value of their own community system of credit.

The last financial statement of the North Carolina Credit Unions is as follows:

MONTHLY FINANCIAL STATEMENT OF NORTH CAROLINA CREDIT UNIONS AS ON SEPTEMBER 30, 1919

Name	Date Opened	Members	Depositors	Payment on Shares	Deposits	Loans	Borrowers	Borrowed from Banks	Cash in Banks	Total Resources
Valdese	Feb. 10, 1917	83	105	$ 2,350.00	$13,702.41	$15,263.73	23	$	$ 1,291.46	$ 16,999.55
*Bahama	April 14, 1916	45	73	570.25	8,545.11	7,775.00			441.45	12,869.48
Carmel	Jan. 26, 1916	113	39	2,039.50	1,636.05	5,260.00	25	1,550.00	219.74	5,593.42
*Sharon	Feb. 10, 1916	73	62	791.85	1,862.19	3,400.00	17	850.00	328.98	3,747.92
Lowes Grove	Jan. 20, 1916	56		1,012.50	837.78	2,970.94	20	1,050.00	42.84	3,112.50
Mount Ulla	Jan. 29, 1918	67	11	590.00	246.90	2,555.22	10	1,638.72	21.37	2,633.51
*Piedmont	April 19, 1918	75	2	867.28	169.75	1,092.33	10	100.00	119.06	1,219.99
Drowning Creek	Mar. 16, 1916	33	5	352.14	45.95	999.48	7	700.00	110.85	1,146.73
Oakdale	Feb. 16, 1916	27	1	218.50	113.58	700.00	10	605.00	185.48	997.84
Eureka	Mar. 17, 1916	30	3	488.75	204.82	388.68	3		309.59	703.09
*Sadler	Mar. 14, 1918	38	3	510.00	175.00	450.00	3		228.30	699.95
Wendell		36	12	86.00	359.22				452.66	582.72
*Angier	Dec. 20, 1918	35	1	454.00	100.00	500.00	1		65.50	565.50
Laurel	Mar. 10, 1917	42	6	510.75	15.50	75.00	1		81.48	554.03
*Lakeview	Jan. 20, 1918	8	3	230.00	7.50				238.25	238.25
Juniper Level		25		194.50					205.75	205.75
*Mount Vernon	Sept. 10, 1917	13	3	100.00	71.64	20.81	1		154.42	188.88
Dundarrach	Feb. 21, 1919	14		85.00		158.75	2	100.00	29.25	188.00
Springfield	July 11, 1919	28		161.25						161.25
*Rosin Hill	Feb. 15, 1919	20		145.00		80.00	1		70.00	150.00
*Franklin	April 6, 1919	19		120.15					119.50	125.75
Jeffries	July 12, 1919	29	8	109.25					116.50	123.00
Warren Plains	June 14, 1919	11		110.00						110.00
*Cleveland	Mar. 29, 1919	18		78.00		51.00	1		24.21	82.71
Arcola		16		67.57					71.50	71.50
*Gold Hill	April 5, 1919	15		62.50					58.75	65.50
Shotwell	July 11, 1919	24		51.50					57.00	57.75
Total Sept. 30, 1919		1,008	337	12,393.21	28,093.42	41,740.94	135	6,593.72	5,086.39	53,437.07
Total Sept. 30, 1918		655	282	7,531.52	11,940.28	21,919.82	161	4,551.40	1,924.96	25,325.98

*According to last report.

The work in credit, however, cannot be measured by any financial statement, however accurate and complete. Much good comes whether or not organization is affected in encouraging farmers to a wiser use of credit. Many farmers do not have the investment point of view, especially in the South, where the ideals of a leisure class have been more prevalent, and where, in consequence, an honorable expenditure of money for consumption may interfere with saving or borrowing capital for money making. The policy has been to show farmers the high cost of supply store credit, and that borrowing is not a misfortune when the rate of interest is low enough and the investment is in an improved equipment or for adequate supplies which permit of a higher rate of return than the rate on the borrowed capital. Undoubtedly, as the agricultural clubs or community organizations get fully established, which are spreading throughout the United States, the credit union will be found a most valuable asset to the farming community in financing the program for the adoption of improved methods of farming advocated by these clubs.

When the individualistic point of view is abandoned by the agricultural institutions, by the schools, churches and by the country community as a whole, the credit unions no longer need work in isolation. Farmers will feel that their only salvation in dealing with vast aggregations of capital is through organization. The credit union is only one of the organizations needed for the development of the rural community. As soon as the closely related organizations, such as organizations for agricultural and social improvement, coöperative selling and buying association, which may or may not be local, are developed, then the suspicion which characterizes the present position of the farmers will be replaced with confidence and efficient teamwork.

No community organization for credit can solve the problem of short-time credit for farmers unless the system provides for regional banks which shall discount the notes of the local credit union. At present the credit union is dependent upon the local bank. But the local bank is generally helpless to meet the enlarged needs for credit extension which occurs at a time of falling prices and of sectional or general industrial depression.

CLASSING COTTON FOR FARMERS AND MILLS

Offices have been established at Tarboro, Wilson, Clinton, Fayetteville, Lumberton and Raleigh for the purpose of serving promptly the farmers of Edgecombe, Wilson, Sampson, Cumberland and Robeson counties. Arrangements were made with all ginners in these counties to send samples of each bale of cotton ginned by them to the nearest office, which samples were identified by numbers corresponding to those upon the bales themselves. Upon their receipt, the samples were classed and the owner of the bale from which the sample was taken was notified of the grade and staple of his cotton and its approximate value, as compared

with the quoted price of middling. The data secured in this and previous investigations indicate that farmers received about one dollar for every cent expended in rendering this service. Twenty-six thousand and eighty-one bales have been classed for farmers in this manner during the present season, and about 4,036 bales were classed for cotton mills.

ESTABLISHMENT OF GRADES AND INSPECTION SERVICE FOR POTATOES

The new Standard Grading and Package Law gives the State Department of Agriculture authority to establish grades and regulations for grading, marking, branding and inspection of all farm products. In conformity to this statute, the Chief of the Division, upon the approval of the Director, issued the grades recommended by the U. S. Department of Agriculture on May 1st, which became the legal grades for North Carolina on June 2, 1919, that is, after thirty days notice required by law. Regulations to cover the grading, marking, branding and inspection of Irish potatoes were promulgated, which became effective on June 7th. Three thousand copies of grades and regulations were mailed and distributed to growers and shippers. The State was divided into four districts and a supervising inspector appointed for each district. The duties of supervising inspectors were (1) to interpret the grades to growers and shippers as far as may be feasible, (2) to see that licensed inspectors inspect according to law and regulations, and (3) to see that there has been a proper compliance with the law for maintaining the standard grades for North Carolina.

One or more inspectors were licensed for each of the leading loading points, who had authority to issue certificates of grade upon application. Five inspectors were licensed for potato exchanges and thirteen for the general public. One hundred and sixty cars of exchange potatoes were inspected and 209 cars for individual growers and shippers. Buyers on three markets coöperated to the extent of requiring that all potatoes be graded and inspected. If potatoes did not come up to grade, these buyers would require growers to run potatoes through a grading machine located at the loading point. It is hoped that this plan may be extended to several other markets the coming year. According to reports received, the grading of early Irish potatoes has been greatly improved in all sections of the State. However, the feeling is that the law, to be most effective, should not give growers the option of not grading or grading according to the adopted standard, but that potatoes offered for sale should be required to be graded and marked according to grade, namely, U. S. 1, or U. S. 2, and with the name of grower or shipper upon each package. Undoubtedly, the inspection service paid the two growers' organizations and the growers and shippers who made use of it. In a year when movement of cars to market was slow, sometimes taking more than a week above the usual schedule, the inspection certificate was

worth more than the two to four dollars which it cost, if for no other purpose than as a basis of settlement of claims with the railroads. Also, in a year of falling prices, determination of condition and grade, before departure of car, is most important to the shipper, as potatoes have largely to be rolled and sold while in transit or consigned.

Very close coöperation was maintained between the Market News Service and the Grading Service. Through inspectors, more loading point markets were reported and more market prices, based upon U. S. Grade 1 and U. S. Grade 2 quoted. A most effective market news service can only be maintained when its quotations are based upon products which have been uniformly graded and inspected to establish and maintain the uniformity of the grade. Only quotations are comparable from those markets which have provisions for maintaining the same standard of products.

This office provided the representative of the Bureau of Markets in charge of the Market News Service with an up-to-date list of potato growers. Statements and instructions in reference to grading potatoes were published on several occasions in the Market News Service Bulletin.

The grading service will also be applied to early sweet potatoes and late Irish potatoes this year, and possibly to late sweet potatoes, and next year to strawberries, cantaloupes and watermelons, and probably apples and cheese. A preliminary survey has been made to find out conditions at loading points to determine upon grades and regulations for cantaloupes. It is felt that even more drastic regulations than the present law probably permits must be applied to secure the proper grading of cantaloupes, and the condemnation and holding by the inspector of cantaloupes and melons which have been picked too green, as is provided for by the California law.

ASSISTANCE IN MARKETING FARM PRODUCTS

Assistance is rendered to individual farmers, shippers and buyers in marketing cotton, corn, soybeans, peanuts, hogs, cattle, sheep, wool, lambs, meat, potatoes, cabbage, and apples. The method followed in cotton is for farmers to send in samples, and for a representative of this division to take the samples to one or more buyers, and then the bids obtained are wired to the owners of the cotton for acceptance or rejection. About 2,500 bales of cotton were marketed in this way. Assistance to individual farmers in marketing farm products is given mainly by mail. Growers are furnished information as to prices and possible buyers on different markets. Lists of buyers are made up as a result of special surveys and furnished to shippers. In response to the inquiries of buyers lists of growers who have the farm products in question for sale are furnished. Wherever the need for a quick transaction exists correspondence is carried on by wire and confirmed by letter.

A considerable demand has developed for our Monthly Farmers' Market Bulletin, in which products are listed for sale. About 3,500 copies of the Market Bulletin were distributed, and 2,500 copies of the Weekly Price Report. The last two publications are of especial assistance to this office in keeping us informed of market conditions in North Carolina towns and counties. The work of collecting a list of purebred livestock and poultry breeders in the State has just been completed and will soon be published in the form of a Directory of North Carolina Breeders of purebred livestock.

PUBLICATIONS

Farmers' Market Bulletin.
Weekly Price Report.
Weekly Hog Market Quotations.
Monthly Review of Producers' Prices.
Monthly Financial Statement of North Carolina Credit Unions.
Articles published in newspapers on Cotton Grading, State Warehouse System, and Peanut, Livestock and Potato Markets.

Respectfully submitted,
Wm. R. Camp,
Chief, Division of Markets,
Acting State Warehouse Superintendent,
Superintendent of Credit Unions.

REPORT ON DRAINAGE

To the Director:

This report, for the year ending June 30, 1919, covers the investigational and experimental work of this division conducted under a coöperative agreement between the North Carolina Department of Agriculture and the United States Department of Agriculture.

Mr. F. O. Bartel was appointed drainage engineer for the North Carolina Department of Agriculture on December 9, 1918, during Mr. E. R. Baker's service in the army, and succeeded Mr. Baker to this position upon his resignation in the summer of 1919.

The investigational and experimental work is connected somewhat with the extension work, since much of the material and many of the locations for experiments are obtained as a result of extension work. Consequently the reports on these two phases of our work overlap.

FARM DRAINAGE

During the past year preliminary examinations, surveys, designs and reports for tile drainage systems have been made on 24 farms in 11 counties, comprising a total area of 1,200 acres. Approximately 12,000 feet of tile have been installed on these farms.

Thirty-six farms, situated in 19 counties, have been visited for the purpose of giving assistance in the location and construction of terraces to prevent hillside erosion; the total length of terraces laid out being approximately 230,000 feet, or 44 miles.

PRELIMINARY EXAMINATIONS AND RECONNAISSANCE

Six examinations of a preliminary or reconnaissance nature have been made and reports issued, covering a total area of 119,000 acres.

RUN-OFF DATA ON DRAINAGE CANALS

The gaging station for the determination of run-off on Third Creek, Iredell County, is still being maintained. Records of daily gage heights are complete from March 17, 1913, to date. In order to determine more accurately the distribution of rainfall on Third Creek watershed, four additional rainfall stations were established in June, 1919, which, in addition to the two at Statesville, N. C., makes a total of six on a watershed area of 44,000 acres.

STUDY OF EFFICIENCY OF UNDERDRAINS

The experiments started in November, 1916, on two of the tile drainage systems at Cotton Valley Farm, Edgecombe County, have been continued and are still in progress. Considerable progress has been made in assembling and plotting the data obtained and in summarizing the results in report form.

Similar experiments were started in April, 1919, on the J. T. Lewis Farm, Pitt County, on a different type of soil. The purpose of the experiments on both farms is to determine:

1. Amount of run-off from underdrained land.
2. Relation of rainfall to run-off.
3. Action of tile drains in lowering the ground water level.

EXPERIMENTAL MAINTENANCE WORK ON DRAINAGE CANALS

In 1917 about two miles of dredged canal through Jacob Swamp, Robeson County, was cleaned out and put in good order. The work was postponed in 1918 on account of war conditions, but was resumed again in May and June of this year on the same section. A summarized report of this work for the years 1917 and 1919 has been prepared. The purpose of this experiment is to study the best methods and cost of maintenance of drainage canals in the State.

In addition to the above classified lines of work, various special investigations have been made.

Respectfully submitted,

H. M. LYNDE,
Senior Drainage Engineer.